MOTOROLA

TRANSISTORIZED

ALERT MONITOR

FM RECEIVER

406-420 MHz
450-470 MHz

12 VDC & 117 VAC

PRINTED IN U.S.A.

68P81067A30-O

MOTOROLA

TRANSISTORIZED

ALERT MONITOR FM RECEIVER

406-420 MHz
450-470 MHz

117 VAC/12 VDC

AEPD-20700-O

MOTOROLA INC. *Communications Division*

ENGINEERING PUBLICATIONS 4501 WEST AUGUSTA BOULEVARD CHICAGO, ILLINOIS 60651

Copyright 1970 by Motorola, Inc.
Printed in U.S.A.

4/23/70-RS

68P81067A30
Issue - O

PERFORMANCE SPECIFICATIONS

MODELS	M04CNB-1100A Series; M04CNB-3100A Series ("Private-Line" Models)
FREQUENCY RANGE	406-420 MHz and 450-470 MHz
SENSITIVITY	Less than 0.7 microvolt for full 20 db quieting
SELECTIVITY (EIA)	-50 db @ ±25 kHz
MODULATION ACCEPTANCE	±5 kHz
CHANNEL SPACING	25 kHz
SQUELCH	Noise Compensated Adjustable Sensitivity: Less than 0.35 uv at threshold. Tone-Coded Type Fixed Sensitivity: Less than 0.35 uv (3100 Series Models only)
TEMPERATURE RANGE AND FREQUENCY STABILITY	Overall stability maintained to within ±.0005% of the assigned center frequency from -10°C to +60°C ambient (+25°C reference)
SPURIOUS RESPONSE	All spurious response attenuated at least 50 db.
IMAGE RESPONSE	Attenuated -35 db or greater.
AUDIO OUTPUT	2.0 watts into a 3.2-ohm load at less than 10% distortion
SEMICONDUCTOR COMPLEMENT	20 transistors; 6 diodes
WEIGHT	Standard squelch receiver: 6-1/4 lbs. Add: 1/2 lb. for tone decoder 3/4 lb. for emergency power supply
DIMENSIONS	3-1/2" high x 11-3/4" wide x 7-1/4" deep
POWER INPUT	Standard Squelch / Selective Calling Model 117 v ac input: At rated audio output = 13 watts / 15 watts +13.8 v dc input: Standby (squelched) = 100 ma / 110 ma At rated audio output = 410 ma / 485 ma
DECODER UNITS FOR SELECTIVE CALL SYSTEMS	Model NLN1046A Single-Tone Decoder *Uses any one of seven tones in the 1800 to 2400 Hz range. Model NLN6578A Two-Tone Sequential Decoder Unit Responds to two separate tones in sequence in the range of 304.7 to 1063.2 Hz. Frequency spacing provides 47 separate available tones. Model NLN6577A "Quik-Call" Decoder Three tone bands available with twelve tones each. Frequency range: 346.7 to 1161.4 Hz. Models NLN6648A, NLN6649A "Private-Line" Tone-Coded Squelch Decoder Uses any one of 26 tones in the 82.5 to 192.8 Hz range.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

*The seven tones available are 1800, 1950, 2000, 2100, 2200, 2250 and 2400 Hz. Tone frequencies should be spaced 150 Hz apart for protection against adjacent channel falsing.

FOREWORD

SCOPE OF INSTRUCTION MANUAL

This manual offers descriptive and service information for the radios described in it. Service diagrams, parts lists, and printed circuit board details are also part of the instruction manual.

NOMENCLATURE

Motorola radio equipment is specifically identified by the model number on the nameplate.

NOTE

Be sure to use the entire model number when making inquires about your equipment.

Identifiers have been assigned to chassis and kits. Use these identifiers when requesting information or ordering replacements.

A model chart is located in the front of this manual.

PRODUCTION CHANGES

When production and engineering changes are incorporated into the equipment, a revision number is assigned to the chassis or kit affected; -1, -2, -3, etc.

The chassis number complete with revision number, if any, is stamped on the chassis at the time of production. The revision number becomes an integral part of the chassis identifier. Revisions, if any, are listed on the schematic diagram.

INSTRUCTION MANUAL REVISIONS

Changes which occur after an instruction manual is printed are described in the Instruction Manual Revision. These bulletins give the reader complete information on the change including pertinent parts listing data.

NATIONAL SERVICE ORGANIZATION

Motorola provides a nation-wide service organization. Through its maintenance and installation program Motorola makes available the finest service to those desiring reliable continuous communications on a contract basis.

The largest service organization specializing in mobile communications is Motorola's National Service Organization. Over 800 strategically located, adequately staffed and trained independently owned and operated stations, manned with several thousand FCC licensed personnel constitute the sub-contracting force.

NATIONAL MOTOROLA COMMUNICATIONS SERVICE

The administrative forces of area and district service managers and district service representatives are in the direct employ of Motorola.

For your contract service requirements, please contact your local Motorola representative or write to:

National Service Manager
Motorola Communications Division
1301 Algonquin Road, Schaumburg, Illinois 60172

CAREFUL USE OF THE INSTRUCTION MANUAL AND THE MANY SUGGESTIONS CONTAINED IN IT WILL FURTHER INSURE PROPERLY INSTALLED AND MAINTAINED RADIO EQUIPMENT

68P81061A73-O

REPLACEMENT PARTS ORDERING

ORDERING INFORMATION

Motorola maintains parts and service depots and authorized service stations strategically located throughout the country. These facilities are fully equipped to give the finest service. Orders for all parts except crystals, channel elements, and "Vibrasender" and "Vibrasponder" resonant reeds should be sent to the nearest parts and service depot. Orders for crystals, channel elements and reeds should be sent to the factory address listed below.

When ordering replacement parts, the complete number identification of the item must be used whether it be a component, kit or complete chassis. This will fix proper identification and assure delivery of the desired item. Complete number identification should also be used when requesting equipment information.

Crystal and channel element orders should specify the crystal or channel element type number, crystal frequency, carrier frequency, and the chassis model number in which the part is used.

Orders for "Vibrasender" and "Vibrasponder" resonant reeds should specify the type number and frequency and should identify the owner/operator of the communications system in which these items are to be used.

PARTS AND SERVICE DEPOTS

2333 Utah Avenue, El Segundo, California 90245
Tel. 213-644-1101 - TWX 910-348-6278

1170 Chess Drive, San Mateo, California 94404
Tel. 415-349-3111 - TWX 910-375-3877

Lake Mirror Road, Forest Park, Georgia 30050
Tel. 404-366-6035 - TWX 810-751-3185

1875 Greenleaf Ave., Elk Grove Village, Ill. 60007
Tel. 312-439-7150 - TWX 910-222-2868

15-00 Pollitt Drive, Fair Lawn, New Jersey 07410
Tel. 201-791-1700 - TWX 710-988-2239

3220 Belt Line Road, Dallas, Texas 75234
Tel. 214-241-2151 - TWX 910-860-5505

12955 Snow Road, Parma, Ohio 44130
Tel. 216-267-2210 - TWX 810-421-8845

FACTORY ADDRESS FOR CRYSTAL, CHANNEL ELEMENT AND RESONANT REED ORDERS

AIR MAIL ORDERS

Motorola, Inc.
Component Service Department
P. O. Box 66191
O'Hare International Airport
Chicago, Illinois 60666

REGULAR MAIL ORDERS AND CORRESPONDENCE

Motorola, Inc.
Component Service Department
916 North Kilbourn Avenue
Chicago, Illinois 60651

68P81061A16-B

CONTENTS

SECTION		PAGE
	Performance Specifications	ii
	Replacement Parts Ordering	iv
	Model Chart	vi
DESCRIPTION		
	Introduction	1
	Receiver Features	1
	Optional Accessories	1
	Selective Signalling Systems	2
	"Private-Line" Systems	2
INSTALLATION AND OPERATION		
	Installation	4
	Antenna and Power Connections	4
	Pre-Operational Checks and Adjustments	4
	Operation	4
THEORY OF OPERATION		
	Receiver	6
	Power Supply	9
	Single Tone Decoder Unit	10
	Two-Tone Sequential Decoder Unit	11
	"Quik-Call" Decoder Unit	16
	"Private-Line" Tone Decoder	20
MAINTENANCE		
	Disassembly Procedures	21
	Performance Checks and Troubleshooting	22
	Performance Checks and Troubleshooting Information	23
	Alignment Procedures	25
SERVICE CHART AND DIAGRAMS		
	Receiver Alignment Procedure	27
	Receiver Printed Circuit Board Detail (NRD6212AB-3 and later)	28
	Receiver Schematic Diagram and Parts List	29
	Single-Tone Decoder Printed Circuit Board Detail	31
	Single-Tone Schematic Diagram and Parts List	32
	Two-Tone Sequential Decoder Schematic Diagram and Parts List	33
	Two-Tone Sequential Decoder Printed Circuit Board Detail	34
	"Quik-Call" Decoder Printed Circuit Board Detail	36
	"Quik-Call" Decoder Schematic Diagram and Parts List	37
	"Private-Line" Decoder Printed Circuit Board Detail	38
	"Private-Line" Decoder Schematic Diagram and Parts List	39

MOTOROLA

MODEL CHART
TRANSISTORIZED
ALERT MONITOR FM RECEIVER
406-420 MHz & 450-470 MHz
117 VAC/12 VDC

CODE:

- [X] = ONE ITEM INCLUDED
- [2] = TWO ITEMS INCLUDED
- [0] = ONE ITEM INCLUDED WITH EVERY FIVE (OR LESS) RECEIVERS
- [4] = FOUR ITEMS INCLUDED
- [/] = ONE ITEM SUPPLIED, CHOICE DEPENDENT ON FREQUENCY

ITEM	DESCRIPTION	M04CNB-1100A	M04CNB-1101A	M04CNB-1102A	M04CNB-1103A	M04CNB-3100A	M04CNB-3105A
	DESCRIPTION	ALERT MONITOR FM RECEIVER (NOISE SQUELCH)	ALERT MONITOR FM RECEIVER (SINGLE-TONE)	ALERT MONITOR FM RECEIVER (TWO-TONE SEQUENTIAL)	ALERT MONITOR FM RECEIVER ("QUIK-CALL" DECODER)	ALERT MONITOR FM RECEIVER "PRIVATE-LINE" DECODER)	ALERT MONITOR FM RECEIVER (TAMPER-PROOF "PRIVATE-LINE" DECODER)
NRE6051AB	RECEIVER CHASSIS (406-420 MHz)	/	/	/	/	/	
NRE6052AB	RECEIVER CHASSIS (450-470 MHz)	/	/	/	/	/	
NRE6047AB	RECEIVER CHASSIS (406-420 MHz & TAMPER-PROOF)						/
NRE6048AB	RECEIVER CHASSIS (450-470 MHz & TAMPER-PROOF)						/
YVSW-143	RECEIVER CONTROL CRYSTAL (406-420 MHz)	/	/	/	/	/	/
YVSW-142	RECEIVER CONTROL CRYSTAL (450-470 MHz)	/	/	/	/	/	/
GN	RECEIVER IF CRYSTAL (15.890 MHz)	X	X	X	X	X	X
NHN6162A	HOUSING AND PANEL KIT	X	X	X	X	X	
NHN6178A	HOUSING AND PANEL KIT, TAMPER-PROOF						X
NLN1046A	SINGLE-TONE DECODER		X				
NLN6577A	"QUIK-CALL" DECODER				X		
NLN6578A	TWO-TONE SEQUENTIAL DECODER			X			
NLN6648A	"PRIVATE-LINE" DECODER					X	
NLN6649A	TAMPER-PROOF "PRIVATE-LINE" DECODER						X
NLN6579A	ESCUTCHEON KIT (NOISE SQUELCH)	X					
NLN6580A	ESCUTCHEON KIT (SELECTIVE CALL)		X	X	X		
NLN6646A	ESCUTCHEON KIT ("PRIVATE-LINE")					X	
NLN6647A	ESCUTCHEON KIT (TAMPER-PROOF "PRIVATE-LINE")						X
TLN6709BG	"VIBRASPONDER" RESONANT REED			2	4		
TLN8381A	"VIBRASPONDER" RESONANT REED					X	X
NKN6122A	AC POWER CABLE	X	X	X	X	X	X
NLN6598A	TUNING TOOL	0	0	0	0	0	0
NLN6634A	TUNING TOOL	0	0	0	0	0	0
NBN6041A	PACKING KIT	X	X	X	X	X	X

DESCRIPTION

1. INTRODUCTION

The Motorola Alert Monitor FM Receiver is a completely transistorized, dual conversion FM receiver with models available in the 406-420 MHz and 450-470 MHz range. It is used for channel monitoring and personnel alerting applications for police, fire and other public safety departments, as well as Civil Defense, utility companies, and other applications. The noise-squelch model monitors all transmissions on the channel. Other models are available with selective signalling options for alerting functions.

The receiver operates from a 117-volt ac, 60 cycle or a nominal 12-volt dc, negative ground source. An emergency battery power supply is available for installation in the receiver for operation in case of power failure.

By interchanging the power cables, the receiver may be operated in a vehicle using the Model NKN6123A DC Power Cable, the Model NLN6588A Mobile Mounting Rack, and a Roof-Top Antenna with the Model NKN6131A Adapter Cable.

2. RECEIVER FEATURES

a. Standard Models

The basic receiver model is supplied with an ac power cord. An antenna receptacle is provided on the rear of the radio. The housing is equipped with a side-mounted handle for ease in carrying.

b. Selective Signalling Models

In addition to the previously-mentioned features for standard models, all selective-signalling models include an indicator light on the front panel to show when an alert call has been received. Two-tone sequential and "Quik-Call" Models also sound an audible tone when a correctly-coded signal is received. A reset switch, is used to restore the alert lamp and the receiver to its normal condition after a call.

Selective-signalling models may be used to receive all on-frequency transmissions by setting the ALERT-MON switch to the MON position.

c. "Private-Line" Models

The standard "Private-Line" model is equipped with a "PL" ON-OFF switch. When the switch is set to the "PL" ON position, the receiver will respond only to transmissions coded with the proper "Private-Line" tone. To hear all on-frequency transmissions, the switch is set to the "PL" OFF position.

The "tamper-proof" version is equipped with an A (Alert) light and a RESET switch. When the properly-coded "Private-Line" signal is received, the red A (Alert) light is illuminated to signal that a message intended for that radio has been transmitted. The light remains on until the RESET switch is pressed, which extinguishes the lamp until the next properly-coded signal is received.

3. OPTIONAL ACCESSORIES

The NLN1045A Emergency Battery Kit is an accessory item which may be installed in the receiver to keep it operating during a power failure. The kit contains a rechargeable nickel-cadmium battery with mounting hardware. The battery is recharged when the receiver is operated from an ac line or when the monitor is receiving power from a vehicle battery.

The NLN6633A Relay Switching Kit provides a contact closure upon receipt of an alert tone in selective calling models. This contact closure may be used to control external audible or visual signalling devices rated not more than 2 amperes at 117 volts ac with not more than 5 amperes maximum inrush current.

Other accessory items are available for a variety of installations. Refer to the following Accessory Table for a complete listing.

ACCESSORY TABLE

MODEL	DESCRIPTION
NLN1045A	Emergency Power Supply and Charger Kit
NLN6588A	Mobile Mounting Rack
NKN6123A	DC Power Cable
NKN6131A	Antenna Adapter Cable
TSN6005A	Auxiliary Speaker Kit (less volume control)
TSN6006A	Auxiliary Speaker Kit (with volume control)
NLN6633A	Relay Switching Kit

4. SELECTIVE SIGNALLING SYSTEMS

a. Model NLN1046A Single-Tone Decoder Unit

This decoder unit adapts the Transistorized Alert Monitor FM Receivers for use in single-tone systems using a single-tone encoder at the transmitter and this decoder unit in the receiver. With these features, the transmitter may selectively call individual receivers, or groups of receivers, on the same rf channel. The decoder will allow only signals with the proper tone code to be heard in the speaker when the ALERT-MON switch is in the ALERT position. Thus, only the receiver or receivers for whom the call was intended will receive the message.

b. Model NLN6578A Two-Tone Sequential Decoder Unit

With this decoder unit, any receiver (or receivers) with a given tone code in a system may be alerted by two selected tones in sequence emanating from the associated transmitter. Upon receipt of the proper sequence of tones, an audible alert tone is generated and an alert lamp is illuminated on the front panel.

The decoder consists of a printed circuit board containing the major circuitry and switches, alert light, and interconnecting cable to the main receiver chassis.

c. Model NLN6577A "Quik-Call" Decoder Unit

"Quik-Call" operation with the monitor receiver is possible when the Model NLN6577A Decoder Unit is installed. With this system, the associated transmitter can alert a specific unit or a group of units at will. A specific unit is alerted with an "individual call" tone code consisting of 2 pulses of 2 tones each, or several units may be alerted as a group with a "group call" tone code, consisting of 1 pulse of 2 tones. The complexity of the calling tone sequence insures small probability of false response to tone signals. An audible tone and a lamp signal the receipt of an alert message.

The decoder consists of a printed circuit board containing the major circuitry, switches, alert light, interconnecting cable to the main receiver chassis, and "Vibrasponder" resonant reeds. The "Vibrasponder" reed passes an audio voltage, at its resonant frequency, which is used to trigger switching circuits. These reeds resonate at specific frequencies in the 346.7 to 1161.4 cycles per second range. For any given system, all "Vibrasponder" reeds used must be of the same series, i.e., "Z", "B" or "A". Refer to applicable portions of the THEORY OF OPERATION section.

5. "PRIVATE-LINE" SYSTEMS

a. "Private-Line" Tone-Coded Squelch Decoders

With these decoders, a receiver or group of receivers may be alerted with a "Private-Line" tone from an associated transmitter. Two types of "Private-Line" decoders are available.

b. Standard Versions

The Model NLN6648A Decoder provides a choice of full "Private-Line" operation, or conventional carrier squelch operation, selectable by a switch. When set for "Private-Line" operation, only messages coded with the sub-audible "Private-Line" tone will be heard. With the "PL" switch in the OFF position, all on-frequency messages will be heard.

c. "Tamper-Proof" Versions

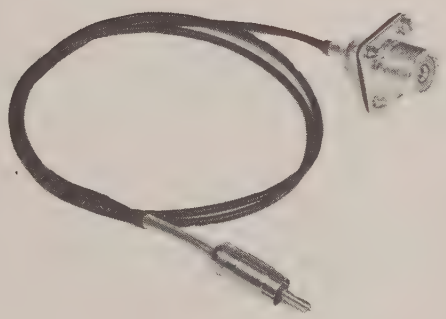
The Model NLN6649A Decoder is available for "tamper-proof" operation. With this decoder, the receiver will respond only to messages modulated with the sub-audible "Private-Line" tone intended for it. When a properly-coded message is received, the A (Alert) light will be illuminated. Pressing the RESET switch will extinguish the light until another properly-coded signal is received.

ACCESSORIES

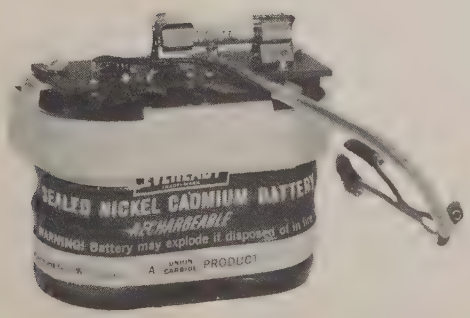
Model TSN6005A (less volume control)
Model TSN6006A (w/volume control)
Auxiliary Speaker Kit

Model NLN6588A
Mobile Mounting Rack

Model NKN6123A
DC Power Cable



Model NKN6131A
Antenna Adapter Cable


SEALED NICKEL CADMIUM BATTERY
RECHARGEABLE
WARNING! Battery may explode if disposed of in fire
A UNION CARBIDE PRODUCT

Model NLN1045A
Emergency Battery Kit

INSTALLATION AND OPERATION

1. INSTALLATION

a. Inspection

Inspect the equipment thoroughly as soon as possible after delivery. If any part of the equipment has been damaged in transit, report the damage to the transportation company immediately.

b. Location

The equipment can be located on a desk top, or other convenient surface. It should, however, be located near a primary power source and the antenna line connection (when an external antenna is used).

2. ANTENNA AND POWER CONNECTIONS

(Refer to Figure 5 in MAINTENANCE section of this manual.)

a. Antenna Connection

Insert the antenna connector of the antenna, the Model NKN6131A Antenna Adapter Cable, or of the feedline to an external antenna into the receptacle on the rear panel of the receiver.

NOTE

The antenna plug must be fully seated into receptacle for proper operation of the receiver.

b. Primary Power Connection

(1) AC Operation

Plug the Model NKN6122A AC Power Cable into the PWR receptacle on the back of the radio and into a 117 volt ac, 60 cycle, single phase outlet.

(2) DC Operation

Connect the Model NKN6123A DC Power Cable to the PWR receptacle on the receiver when it is to be used in a vehicle. Be sure that the vehicle is equipped with a 12-volt, negative ground only electrical system before inserting the cable plug into the cigar lighter receptacle. Do not attempt to operate the radio on a positive ground electrical system.

c. External Speaker Connection

For external speaker operation, solder a phone plug (28A804790) to one end of a two-conductor cable (30B865857). Solder the other end of the two-conductor cable to the external speaker terminals. Insert the phone plug into the SPKR receptacle on the rear of the radio set. Be sure that the plug is firmly seated.

3. PRE-OPERATIONAL CHECKS AND ADJUSTMENTS

These checks and adjustments should be made before placing the receiver in service. They are necessary due to the possibility of mishandling in transit and the wide range of operating conditions. Refer to the performance checks in the MAINTENANCE section of this manual. If the readings are beyond the given limits, align the receiver as prescribed in the alignment procedure.

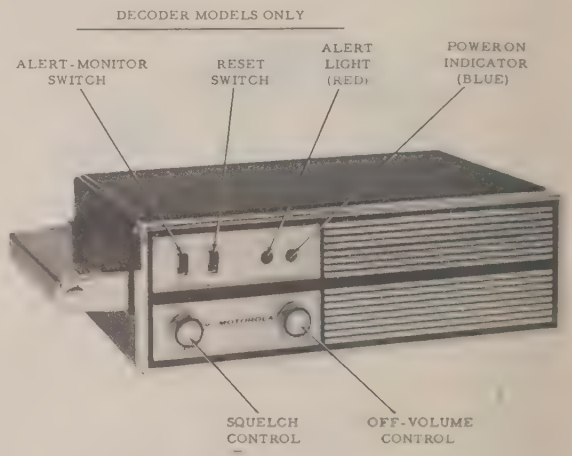


Figure 1.
Location of Operating Controls

4. OPERATION

(Refer to Figure 1)

a. Receivers without Decoder Units

(1) Turn the power "on" by rotating the OFF-VOL control clockwise until a "click" is heard. When external power is applied to the radio, the blue P (power) lamp will light.

(2) Turn the SQUELCH control fully counter-clockwise.

(3) When a signal is received, adjust the OFF-VOL control to the desired level.

(4) When no signal is being received, rotate the SQUELCH control clockwise until the background noise is just squelched (cut out). Turning the control past this point will decrease the sensitivity of the receiver, possibly causing some messages to be missed.

b. Receiver Models with Single-Tone, Two-Tone Sequential and "Quik-Call" Decoder Units

When initially placing a single-tone decoder-type unit in service, refer to the performance checks outlined in the MAINTENANCE section of this manual. The "Quik-Call" and two-tone sequential decoders require no special alignment.

After completing the initial installation procedures, perform the routine pre-operational adjustment procedure that follows.

(1) Set the ALERT-MON switch to the MON position.

(2) Turn the power "on" by rotating the OFF-VOL control clockwise until a click is heard. When external power is applied to the radio, the blue P (power) lamp will light.

(3) Turn the SQUELCH control fully counter-clockwise.

(4) When a signal is received, adjust the OFF-VOL control to the desired level.

(5) When no signal is being received, rotate the SQUELCH control clockwise until the background noise is just squelched (cut out). Turning the control past this point will decrease the sensitivity of the receiver, possibly causing some of the messages to be missed.

(6) After the volume and squelch controls have been properly set, move the ALERT-MON switch to the ALERT position.

(7) Upon receipt of a properly tone-coded signal, the red A (Alert) lamp will light. The receiver will unsquelch, and an alerting tone will be heard in two-tone sequential and "Quik-Call" models followed by the message intended.

(8) After the receiver is alerted, the unit will receive all on-frequency messages until the RESET switch is actuated momentarily. The receiver will then remain squelched until the next properly tone-coded signal is received.

CAUTION

Do not press the RESET switch while an alert tone or message is being received, or the message will not be heard. If the RESET switch is pressed during the tone or voice message, move the ALERT-MON switch to the MON position immediately to avoid missing the message.

(9) The A (alert) light may be tested by pressing the RESET switch. The lamp should remain lit as long as the switch is depressed.

c. Receiver Models with "Private-Line" Decoder Units

When initially placing a "Private-Line" decoder-type unit in service, refer to the performance checks outlined in the MAINTENANCE section of this manual. After the initial installation procedures have been carried out, the routine pre-operational procedures are as follows:

(1) Models with "PL" ON-OFF Switch

(a) Set the "PL" ON-OFF switch to the "PL" OFF position.

(b) Turn the power "on" by rotating the OFF-VOL control clockwise until a click is heard. When external power is applied to the radio, the blue P (power) lamp will light.

(c) Turn the SQUELCH control fully counterclockwise.

(d) When a signal is received, adjust the OFF-VOL control to the desired level.

(e) With no signal being received, rotate the SQUELCH control clockwise until the background noise is just squelched (cuts out). Turning the control past this point will decrease the sensitivity of the receiver, possibly causing some of the messages to be missed.

(f) After the volume and squelch controls have been properly set, move the "PL" ON-OFF switch to the ON position.

(g) Upon receipt of a properly-coded "Private-Line" signal, the receiver will unsquelch for the duration of the message, allowing it to be heard. With the switch in the "PL" ON position, only messages with the proper "Private-Line" tone code will be heard.

(i) To hear all on-frequency messages, move the "PL" ON-OFF switch to the OFF position.

(2) Models with RESET Switch

(a) Turn the power "on" by rotating the OFF-VOL control clockwise until a click is heard. When external power is applied to the radio, the blue P (power) lamp will light.

(b) Press the RESET switch. The red A (Alert) lamp will light while the switch is depressed. Release the switch. The receiver will remain quiet until a "Private-Line" tone-coded signal is received.

(c) Upon receipt of a correctly-coded "Private-Line" signal, the receiver will unmute, allowing the message to be heard. The red A (alert) lamp will light, and remain lit. Press the RESET switch to extinguish the lamp.

THEORY OF OPERATION

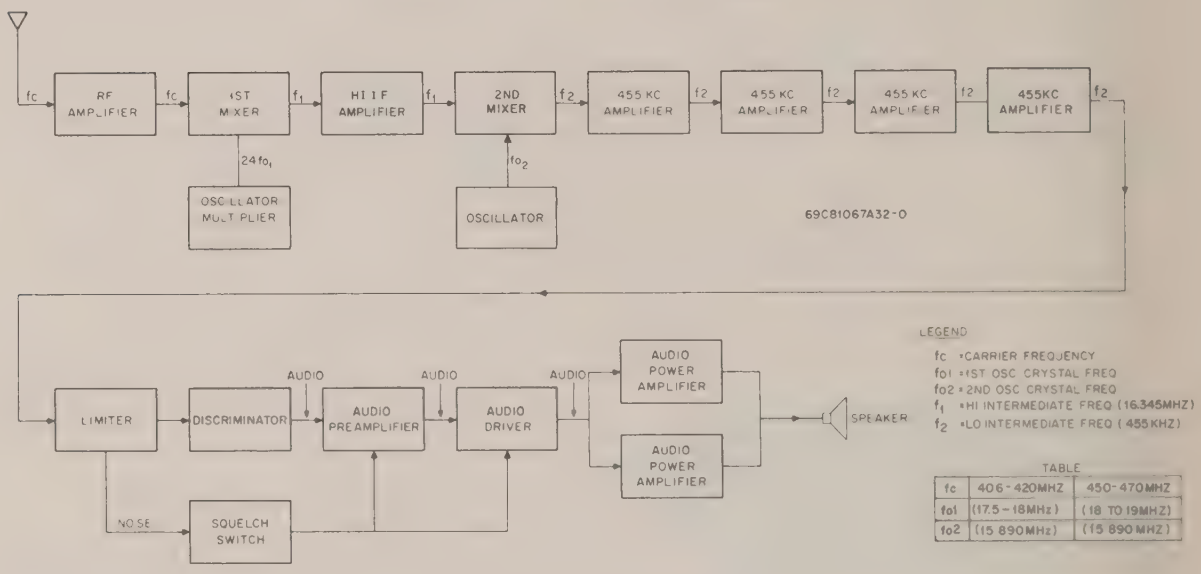


Figure 2.
Receiver Block Diagram

1. RECEIVER

a. General
(Refer to Receiver Schematic Diagram)

This receiver is an FM dual-conversion superheterodyne type and operates on a single fixed, crystal-controlled frequency in the 406-420 MHz or 450-470 MHz range. The receiver, consisting of rf and i-f stages, an oscillator, audio and squelch stages, power supply, and regulator circuits, is contained on one printed circuit board. When used as a noise squelch receiver, it monitors all on-frequency transmissions. However, when selective signalling devices such as the single-tone, "Quik-Call", two-tone sequential and "PL" decoders are used, only messages for the specific unit are received.

b. RF Amplifier

The antenna is coupled thru a band-pass filter consisting of C76, C78, and L16, and then matched to the base of Q1 by C75. The diode prevents a large static charge from building up on the antenna. The rf signal is then amplified by Q1. Additional selectivity is obtained by the coupling network between Q1 and the Tripler-Mixer Q2. The output coil L8 is tapped to match the base circuit of Q2. The shunt capacitance of the Q2 base circuit is also used to tune coil L8.

c. First Oscillator-Multiplier

An injection signal which mixes with the rf signal at the base of Q2 originates from the oscillator circuit Q5. This oscillator is a modified

Colpitts type with a series-tuned feedback circuit (Y3 and L15). Frequency stability is determined by crystal Y3. The oscillator frequency can be changed an incremental amount (warped) by adjustment of L15. A tuned circuit (L18 and C17) in the Q5 emitter circuit selects a frequency eight times that of the basic oscillator frequency. This signal is then coupled thru another tuned circuit (L13 and C7) and becomes the oscillator injection signal routed to the Tripler-Mixer stage Q2.

Regulated voltages, from Regulator Transistor Q21, are supplied to the RF amplifier, Tripler-Mixer, and Oscillator stages so that normal operation will be unaffected by varying supply voltages.

d. Tripler-Mixer

This stage combines the rf signal with the third harmonic component of the injected oscillator signal (24 times the basic oscillator frequency due to tuned circuit L8B and stray capacitance) to produce the high (first) i-f frequency of 16.345 MHz at the collector of Q2. The i-f signal is then impedance-coupled to the base of the High IF Amplifier Q20.

e. High IF Amplifier

Output signals from the Tripler-Mixer stage are amplified by Q20 in a common-emitter arrangement. Four tuned tank circuits provide selectivity at the high i-f frequency, with the last tuned circuit being capacitively coupled to the Second Mixer Transistor Q3.

f. Second Oscillator

Crystal-controlled second oscillator Q6 uses an N-P-N transistor in a common-collector emitter follower configuration. The frequency of the second oscillator is 12.155 MHz or 11.245 MHz which is 455 kHz above or 455 kHz below the high i-f frequency of 11.7 MHz. This oscillator frequency is not adjustable. An output from the emitter of Q6 is applied to the base of second mixer transistor Q3 along with the intermediate frequency.

g. Second Mixer

Signals from the second oscillator are heterodyned with the intermediate frequency in second mixer stage Q3 to produce a frequency difference of 455 kHz. This is the low i-f or second intermediate frequency. The second mixer is an N-P-N transistor arranged in a common emitter configuration.

h. 455 kHz Filter

A lattice type 455 kHz ceramic filter is between the output of second mixer stage Q3 and the input to the 455 kHz i-f amplifier stages. This filter has a bandwidth of approximately 12 kHz and determines the adjacent channel selectivity of the receiver.

The second i-f signal is coupled to the filter from the second mixer and is reduced to a low voltage by transformer T3. The signal then passes through resonators Y1 and Y2 to transformer T8 which increases the signal voltage. Transformers T3 and T8 are both resonant at 455 kHz.

When the second i-f signal is exactly 455 kHz, both Y1 and Y2 couple the same amount of signal to the output. When the signal is at the resonant frequency of a resonator (Y1 = 452 kHz; Y2 = 458 kHz) most of the signal is coupled to the output by that resonator and very little passes through the other resonator. Signals within approximately ±3 kHz of the resonator frequency will easily pass through the filter.

Signals that are not close to 455 kHz or the frequencies of the resonators will be greatly attenuated. These signals are rejected by the selectivity of tuned transformers T3 and T8 and by the balancing action of a bridge network (secondary of transformer T3 and resonators Y1 and Y2). The points of maximum rejection, at which the bridge balances, are controlled by capacitor C42.

The components of this filter are not encapsulated but are mounted individually on the printed circuit board. The filter is, therefore, serviceable since parts may be removed and replaced as necessary.

i. 455 kHz IF Amplifiers

Signals from the output of the 455 kHz filter are capacitively coupled to the base of first 455 kHz i-f amplifier Q4. There are four 455 kHz i-f amplifier stages. All stages (Q4, Q7, Q8 and Q9) use N-P-N transistors arranged as common-emitter amplifiers. Most of the gain of the receiver is contained in these amplifiers, with each stage having approximately 20 db of gain. Metering point J5-1, located in the base circuit of Q8, is used for alignment and is also used when making service measurements.

j. Limiter

Limiter stage Q10 follows the 455 kHz intermediate frequency amplifier stages. This stage

is basically the same as the 455 kHz i-f amplifiers. However, due to the level of signal reaching this stage, the base voltage will appear as a negative voltage and the transistor, Q10, is thereby reverse biased. Its function is to remove amplitude variations in the received signal, leaving only variations in frequency to be coupled to the discriminator.

NOTE

If the signal being received is of sufficient strength, the fourth 455 kHz i-f amplifier will also appear to be reverse-biased and will, therefore, be producing a limiting action.

When Q10 receives an incoming signal of sufficient amplitude, it starts to limit by saturating on the positive half of the cycle and cutting off on the negative half on the cycle. Thus, the limiter stage operates between saturation and cut-off and performs its function of removing amplitude variations from the received signal, leaving only variations in frequency to be coupled to the discriminator.

k. Discriminator

The discriminator diodes and associated circuitry translate the frequency variations of the 455 kHz i-f signal from the limiter into corresponding amplitude variations which represent the recovered audio modulation of the received signal. A tuned circuit, consisting of the secondary of T4 and capacitors C54 and C55, is adjusted for resonance at 455 kHz. At resonance, equal voltages are applied to diodes CR5 and CR6, producing a zero voltage at the output of the discriminator. As the incoming i-f signal varies in frequency (at an audio rate) above and below 455 kHz, the resonant circuit appears capacitive or inductive and applies unequal voltages to diodes CR5 and CR6. This results in a negative voltage output under one condition and a positive voltage under the other condition. The output thus varies from positive to negative through zero and from negative to positive through zero at an audio rate. This varying output passes through the volume control and is applied to the audio preamplifier stage.

l. Audio Stages

(1) Audio Preamplifier Stage

Audio signals at the volume control are capacitively coupled to the base of audio preamplifier transistor Q11. The circuit uses an N-P-N transistor arranged in a common-collector or emitter follower configuration. Signals are directly coupled from the emitter of Q11 to the base of audio driver transistor Q12. Control voltages from the squelch switch stages (Q17 and Q18) are applied to the emitter of audio preamplifier transistor Q11. These dc control voltages vary the emitter voltage of Q11 allowing the transistor to conduct during the reception of a signal or causing it to be cut off when a signal is not present. Refer to the squelch switch stages (paragraph l) for a detailed explanation of the squelching of the audio stages.

(2) Audio Driver Stage

Audio signals from audio preamplifier stage Q11 are direct coupled to the base of the audio driver stage, Q12. The conduction of this stage, a P-N-P, common emitter amplifier, is controlled by its base voltage which, in turn, is controlled by the emitter voltage of audio preamplifier transistor Q11. When Q11 is conducting, audio driver transistor Q12 is also conducting. Signals on the base of this transistor are amplified and appear in the collector circuit of the stage where they are transformer coupled to the audio power amplifier stage.

(3) Audio Power Amplifier Stage

A push-pull power amplifier stage completes the audio section of the receiver. Signals are transformer coupled by transformer T5 from audio driver stage Q12 to the bases of P-N-P power amplifier transistors Q13 and Q14. CR7 and R57, connected to the emitters of Q13 and Q14 via R58, compensate for temperature variations. Capacitors C72 and C73 introduce negative feedback in the power amplifier stage to aid in reducing the amount of distortion in the audio stages. The audio power amplifier stage drives the loudspeaker via output transformer T6 at an audio level up to 2 watts. A jack (J2) is provided to connect an external 3.2-ohm speaker in series with the speaker in the unit.

m. Squelch Switch Stages

(1) Squelched Condition

Squelch switch stages Q17 and Q18 activate the audio stages during the time a signal is received and disable or mute the audio stages during the period no signals are present.

A portion of the noise present in the collector circuit of limiter stage Q10 (when no signal is being received) is coupled by capacitor C63 to squelch control R39. This control in in the base circuit of N-P-N squelch noise amplifier transistor Q17. With no noise input (or squelch control at minimum), the stage is cut off. As the noise input is increased (or the squelch control is turned to maximum), the dc base voltage goes negative which

would appear to cut off transistor Q17 even more. However, the positive alternations of noise are of sufficient amplitude to drive transistor Q17 into conduction. During the time that Q17 is conducting, its collector potential swings in a negative direction, approaching zero or ground potential. As the collector voltage of Q17 changes in a negative direction, a shift in base voltage at squelch switch transistor Q18 occurs. This shift of voltage in a negative direction forward biases the base-emitter junction of transistor Q18, turning on the transistor. This causes the collector potential of Q18 to approach the emitter voltage which is the supply voltage.

The positive change in voltage on the collector of Q18 is applied to the emitter of audio preamplifier stage Q11. The change is sufficient to make the emitter potential of Q11 more positive than the base voltage. Since Q11 is an N-P-N transistor, a reverse-bias condition now exists; audio preamplifier transistor Q11 is cut off and the audio stage is muted or squelched.

Audio driver stage Q12 will also be cut off or squelched since a change in emitter voltage of Q11 will also change the base voltage of Q12. Since the emitter of Q11 is direct coupled to the base of Q12, a positive voltage change on the emitter of Q11 produces a positive change in the base voltage of Q12. A reverse-bias condition now exists on P-N-P audio driver transistor Q12 and the stage is cut off or squelched. Thus the squelch stages control both the audio preamplifier stage and the audio driver stage.

(2) Unsquelched Condition

As a signal is received, the amount of noise present in limiter stage Q10 drops to a very low level. Only a 455 kHz signal is present and the bottom of the primary of transformer T4 (in the collector circuit of Q10) is essentially at ground potential to a 455 kHz signal. Thus, no signal is present at the input to the squelch switch stages. Transistor Q17 is cut off at this time and its collector is at its highest positive potential. With the collector voltage at its maximum positive voltage, the base of Q18 is also at its maximum positive potential which creates a reverse-bias condition for the base-emitter junction of transistor Q18. As Q18 is reverse-biased, its collector potential will swing in a negative direction. Since the emitter of audio preamplifier Q11 is directly coupled to the collector of Q18, the emitter potential of Q11 also swings in a negative direction. This creates a forward bias condition for Q11 and allows the incoming audio to be amplified. The changing voltage on the emitter of Q11 also causes a change in the base potential of Q12, allowing Q12 to become forward biased. Both the audio preamplifier and the audio driver are now forward biased (unsquelched).

n. Power Amplifier Squelch

In the absence of a received signal, the audio preamplifier and audio driver stages are cut off (squelched). Under this condition, no current is drawn through transistor Q12. With no current, there is no voltage drop across resistor R55 in the collector circuit of Q12 (resistor R55 is also in the base circuit of the power amplifier squelch transistor Q19). Since there is no voltage drop across resistor R55, the base of Q19 is at ground potential and the transistor is cut off. While the transistor is cut off, the voltage divider (of which Q19 is a portion) is essentially an open circuit. This prevents power amplifier transistors Q13 and Q14 from becoming forward biased since there is no complete path for current flow to establish the proper base voltages. Thus, the power amplifier stage is cut off, blocking any signal from reaching the speaker and minimizing the standby current drain.

When a signal is received, current flows through audio driver transistor Q12 and consequently through resistor R55. At this time, there is a voltage drop across resistor R55, causing a forward-bias condition for power amplifier squelch transistor Q19, driving it into saturation. The collector of transistor Q19 is now at ground potential and the path for current flow in the power amplifier transistor base circuit is complete. A forward bias condition now exists for the power amplifier stage, allowing audio signals to reach the speaker.

2. POWER SUPPLY

a. General

The power supply provides A+ voltages for the receiver and the tone decoder boards (if used). The input to the power supply may be either from a 117-volt ac or a 12-volt dc negative ground source. Power for the receiver may also be supplied by an internal 10 volt nickel-cadmium battery used primarily for emergency service. This internal power supply charges as long as external power is applied to the unit. If the external power source fails, the internal battery automatically supplies voltage to the receiver.

When either the 117-volt ac or the 12-volt dc primary power is used, a two-transistor series

regulator circuit provides regulated voltages to the receiver and the tone decoder boards. When the 10-volt emergency supply, is furnishing power, the regulator circuit is not used. Power is supplied directly to the receiver and the tone decoder boards.

b. Input Circuit

(1) AC Operation

The primary power input receptacle accepts an input cable from either a 117-volt ac or a 12-volt dc source. The receptacle is keyed to prevent wrong insertion of the plug. When the input is from the 117-volt ac source, power is applied to pins 2 and 3 of receptacle J4. These pins are fused and connect to the primary of a step-down transformer T7. Approximately 20-volts ac is present across the secondary of transformer T7 when power is applied. Diode CR1 provides half-wave rectification of the ac voltage, producing a dc voltage which is applied through switch contact S1-A to a filter network and to the series regulator circuit.

(2) DC Operation

When the power input is from an external dc source, power is applied to pins 1 and 4 of receptacle J4. Pin 4 is connected to ground and pin 1 ties directly to switch contact S1-A. Thus, the dc input is applied directly to the series regulator circuit which, in turn, supplies the voltages for the receiver and tone decoder boards.

c. Regulator Circuit

The input to the regulator circuit is a dc voltage (from either the ac source via rectification or directly from the dc source). Following the filter circuit, a network consisting of resistor R29 and a nominal 13.25-volt Zener diode (CR2) is used to establish a reference voltage for the base of control transistor Q16. The emitter of Q16 senses any change in the load on the output of the regulator circuit. (A change in loading produces a slight change in emitter voltage.) Since the base voltage is fixed by Zener diode CR2, a change in bias of transistor Q16 occurs which changes the conduction of the transistor. A change in conduction causes a change in collector voltage and a change in the base voltage of series regulator transistor Q15. Again, the change in base voltage affects the bias of transistor Q15, controlling conduction and determining the voltage drop across the transistor and, the output voltage from the regulator circuit. Thus, changes in output voltage of the regulator are sensed and compensated for by increasing and decreasing the conduction of (and the voltage drop across) transistor Q15.

3. SINGLE-TONE DECODER UNIT

(Refer to Single-Tone Decoder Schematic Diagram)

a. General

The single-tone decoder consists of an emitter follower stage, a tone amplifier, a tuned LC circuit followed by an emitter follower stage, a second tone amplifier, a two-transistor detector and an integrator or timing circuit, a lock-up network, a control transistor, a switching transistor and a squelch control circuit. Provisons are also made for activating an optional relay switching kit. The decoder connects to the receiver through a five-conductor cable.

b. Operation with On-Frequency Tone

When a signal modulated by the proper single-tone frequency is received, a portion of the recovered audio is applied to the single-tone decoder via P1-4. This signal is coupled to N-P-N emitter-follower stage Q101 which provides a high input impedance to prevent discriminator loading. From the emitter of Q101, the signal is coupled to N-P-N tone amplifier stage Q102. In the collector circuit of Q102, a tuned LC circuit (L101-C114) exhibits resonance and presents a high impedance to the desired tone signal. The signal developed across this high impedance is coupled to second emitter-follower stage Q103. This stage effectively isolates the tuned LC circuit from undesirable loading effects of the subsequent stages. The output from Q103 is applied to second tone amplifier stage Q104. In the emitter circuit of Q103, DRIVE ADJUST potentiometer R109 adjusts the amplitude of the signal. This determines the dynamic bandwidth capability of the decoder.

After being amplified by second tone amplifier stage Q104, the signal is coupled to a circuit consisting of transistors Q105, Q106 and associated components. This circuit, designated a tone switch, is a detector and an integrator or timing circuit. The tone switch circuit provides protection against falsing (undesired triggering of the alarm circuit) by requiring the selective calling tone to be present for a duration longer than that of a normal voice peak or noise pulse.

When a positive-going signal is present at the input of transistor Q105, the normally cut off transistor starts to conduct. The collector voltage of

Q105 decreases toward ground potential at a rate proportional to the magnitude of the signal at the base. The collector voltage is prevented from going immediately to ground potential by the charging of capacitor C107. As the collector voltage of Q105 decreases, the voltage at the base of Q106 decreases but at a slower rate due to the integration time of resistor R116 and capacitor C108. This integration time is 2.25 seconds (R116=470K; C108=15 uf) and requires the sustained presence of the proper tone for approximately 3 seconds. This minimizes the chance of decoder falsing during certain voice transmissions. If the proper tone is present for the correct duration, he base potential of Q106 falls below that of its emitter, and the transistor coducts. If the tone duration is too short, the base voltage at Q106 does not drop to a low enough potential to saturate Q106.

Diode CR101 is used to keep capacitor C108 discharged when the alert monitor is first turned on. This permits a fast recovery time for the circuit to prevent A+ falsing.

Q106 conducts until the tone ends, causing its collector potential to swing in the positive direction. This positive-going voltage from the collector of Q106 is applied to the anode of diode CR102, forward biasing the diode. With diode CR102 forward biased, the base potential of transistor Q108 moves in a positive direction, causing a forward bias condition to exist at the base-emitter junction of Q108.

With transistor Q108 conducting its collector voltage changes in the negative direction. Since the base of Q109 is directly coupled to the collector of Q108, the base voltage of Q109 will also change in a negative direction causing Q109 to conduct. When Q109 conducts, its collector voltage is approximately equal to the A+ voltage. This rise in collector voltage causes current to flow through resistor R128 and lamp DS101. As this occurs, the visual indicator A (red alert lamp) illuminates indicating that an alerting signal has been received

At the same time, the positive voltage existing at the collector of Q109 is applied to the base of transistor Q107. A forward bias condition is established for Q107 and the transistor saturates. The collector of Q107 is now at ground potential. This places a ground at J1-3 via P1-3 on the receiver board, completing the squelch switch stage circuit path which turns the audio stage on.

The A+ voltage at the collector of Q109 is also applied to the base of Q108. This keeps Q108 conducting which, in turn, maintains Q109 and Q107 in conduction. Therefore, once alerted, the visual indicator A (red alert lamp) lights and the receiver audio stages are turned on. The unit now receives all messages until RESET switch S102 is operated. The manually operated spring return RESET switch when placed in the reset (up) position, disconnects the emitter circuit of Q109. This removes the lock-up voltage which was fed back to the base of Q108. When the switch is released, the stages which were held "on", return to their original state. The receiver also returns to its original condition and is ready to be activated by the next single-tone encoded transmission. The collector voltage of Q109 is also applied to P1-1 which activates the relay switching kit (if used) when the decoder is alerted.

The decoder is also operative when ALERT-MON switch S101 is placed in the MON position. The A (Alert) light will turn on whenever the proper tone-coded message is received. All messages, tone-coded or not, will be heard.

c. Operation with an Off-Frequency Tone

The received signal proceeds through the first two stages of the decoder in the same manner as an on-frequency tone. However, once the signal reaches the tuned circuit (L101-C114), a low impedance to ground is presented to the off-frequency tone. Therefore, no signal is coupled to the subsequent stages. The receiver audio circuit remains unactivated.

4. TWO-TONE SEQUENTIAL DECODER UNIT

(Refer to Two-Tone Sequential Decoder Schematic Diagram)

a. General

The two-tone sequential decoder consists of tone amplifiers, followed by two separate but similar tone channels. These channels, when activated in the proper sequence, activate a tone oscillator, establish a blocking circuit which blocks audio during the alerting period, and completes a path for the squelch switch stages. An output from the decoder board is also made available to activate the optional relay switching kit (if used). The decoder connects to the receiver through a seven-conductor cable.

b. Circuit Operation

When a signal modulated with the proper sequential tones is received, an output from the discriminator is applied to the decoder via connector P1-4. This signal is coupled to the base of Q302, an emitter-follower stage. This arrangement provides a high impedance input and prevents loading of the discriminator by the decoder circuit.

From the emitter of Q302, the signals are coupled to reed driver Q303 for amplification. The collector output of Q303 is applied to the "Vibrasponder" resonant reeds. Each reed is activated by a particular tone code. These tones, designated A (first tone) and B (second tone), must arrive in the proper sequence to provide the alert tone at the speaker. Tone A is transmitted for 1 second, followed within 300 milliseconds by 3 seconds of tone B.

The "Vibrasponder" resonant reeds used are of the two coil, single-tine type. If a tone equal in frequency to that of the mechanical resonance of the "Vibrasponder" reed is applied the reed will vibrate strongly, acting as the electromechanical coupling device between the input and output coils. Therefore, each reed can be considered to be a very narrow bandpass filter which passes only the desired paging tone.

Diode CR302 (Germanium) in the collector circuit of transistor Q303 is effectively in parallel with the input coils of both "Vibrasponder" reeds. This diode limits the peak amplitude of the input signal to 0.2 volt maximum to insure a constant input to the reeds. Also, the possibility of falsing is decreased by limiting any voice and noise peaks that may be coupled to the reeds.

When tone A is received, it is passed through "Vibrasponder" reed "A" and capacitively coupled to the base of reed amplifier Q305. The tone is amplified and coupled from the collector of Q305 through C310 to the base of Q308. Transistors Q308 and Q310 form a trigger circuit and are both normally cut off. When an input is received at the base of Q308, the transistor begins to conduct and its collector goes negative (i.e., less positive). This transition is coupled through R320 to the base of Q310, causing it to conduct and its collector to go in a positive direction. Resistor R320 and capacitor C313 in the base circuit of Q310 introduce some integration time for protection against false response. The positive transition at the collector of Q310 is coupled through R317 back to the base of Q308, increasing its forward bias and causing greater conduction. The positive potential at the collector of Q310 forward biases CR305 allowing it to conduct and couple a positive potential to the collector of C314. Capacitor C316 acts as a filter, keeping the positive dc potential at the anode of CR305 relatively constant during the positive and negative half cycles of tone A. Q314 and Q317 form a basic monostable multivibrator circuit, with Q314 normally cut off and Q317 conducting (saturated). Figure 3. illustrates the waveforms at various points in the multivibrator and clamp circuits during the "on" and "off" periods of tone A and the start of tone B transmission.

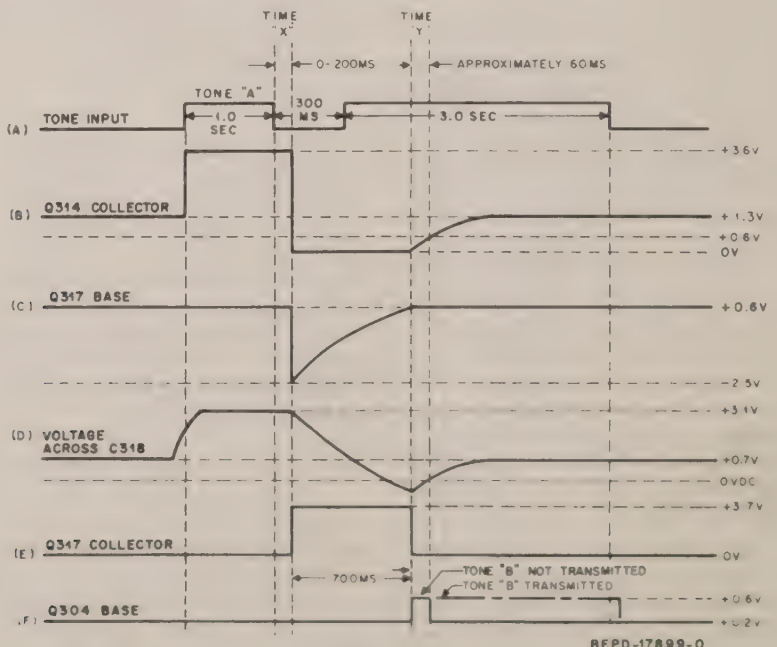


Figure 3.
Waveform Detail

Prior to the conduction of CR305, the potential at the collector of Q314 is approximately 1.3 volts dc which is established by the resistive divider network consisting of R334 and R335. This voltage is fed through R329 to the base of transistor Q312, the clamp stage, providing forward bias for the transistor and allowing it to conduct to saturation. The path of conduction for Q312 is from ground through resistor R327, transistor Q312 and resistors R306 and R307 in the base-collector circuit of Q304, to the B+ supply. The base of Q304 is effectively clamped to approximately zero volts (through transistor Q312), cutting off the transistor. With Q304 cut off, the trigger circuit (consisting of Q307 and Q309) cannot operate which, in turn, keeps the tone oscillator (Q316 and Q313) deactivated. Since the tone oscillator is deactivated until tones A and B arrive in proper sequence, false alerting is prevented.

When CR305 conducts, the voltage at the collector of Q310 is coupled to the collector of Q314, increasing its potential to 3.6 volts dc (shown as waveform B in Figure 3.). As noted previously, Q317 is normally conducting, and remains conducting, throughout the increase in potential at the collector of Q314. A forward bias of 0.6 volt dc is established at the base of Q317 through its emitter-base junction and R340. With the potential at the collector of Q314 at 3.6 volts and the base of Q317 at 0.6 volt dc, the effective potential across C318 increases from its normal value of 0.7 volts to 3.0 volts dc. (See waveform D in Figure 3.)

NOTE

The normal value of 0.7 volts dc across C318 results from the difference between the collector potential of Q314 (1.3 v dc) and the base potential of Q317 (0.6 v dc).

The multivibrator will remain in this state for the remainder of tone A transmission and the time period shown as "X" on the waveform detail (time "X" is the period required for the "Vibrasponder" reed to stop vibrating once tone A has stopped). At the end of time period "X", the trigger circuit (Q308 and Q310) will revert to its former condition (i.e., both transistors cut off). The collector of Q310 will return to zero and CR305 will again be back-biased, cutting the diode off. When this occurs, the collector of Q314 tends to return to 1.3 volts, thus generating a negative-going transition which is coupled through C318 to the base of Q317, cutting it off. The collector of Q317 now approaches the 3.6 volt dc supply potential. This positive transition is fed through R330 to the base pf Q312, sustaining the forward bias previously established through R329 and keeping the transistor conducting. This will, as previously described, disable amplifier Q304, trigger circuit Q307 and Q309, and tone oscillator Q313 and Q316. The positive transition at the collector of Q317 is also coupled through R331 to the base of Q314 driving it into saturation. The collector of Q314 will approach zero potential. C318 now begins to discharge, then slightly reverse charge through Q314 and R340. When the voltage reaches 0.6 volt, Q317 will again conduct, the collector will return to zero potential, and Q314 will be cut-off. The collector of Q314 will now attempt to return to its normal cut-off potential of 1.3 volts. However, due to the charging of C318, this is not accomplished instantaneously. Therefore, with the collector of Q317 at zero and the collector of Q314 in transition from zero potential, a short period of time exists (shown as time "Y" on the waveforms in Figure 3.) when there is no positive forward bias applied to Q312, the clamp stage. In this time period, Q312 will cut-off and amplifier Q304 will conduct (see waveform F in Figure 3.).

At this time, tone B will be applied to the decoder, amplified by the tone amplifiers, and will pass through "Vibrasponder" B to the base of Q304. Operation of amplifier Q304 and trigger circuit Q307 and Q309 is essentially the same as previously described for amplifier Q305 and the trigger circuit consisting of Q308 and Q310. However, as Q309 conducts, its collector goes positive applying reverse bias to the emitter-base junction of Q312 (the clamp stage), sustaining its cut-off condition and permitting Q304 and the succeeding stages to continue functioning throughout the duration of tone B transmission.

The positive pulse from the collector of Q309 activates several circuits. When the collector of Q309 goes positive, diode CR304 becomes forward biased, causing the base of Q311 to go positive. Bi-stable transistors Q311 and Q315 are used to illuminate the "A" visual indicator. This circuit is slightly different from the normal bi-stable circuit in that transistor Q311 is an NPN transistor while transistor Q315 is a PNP. This means that both transistors will be "on" at the same time and "off" at the same time. When the base of Q311 goes positive, the transistor will turn on and its collector potential will move in a negative direction. The negative change in voltage is directly coupled to the base of Q315, causing Q315 to turn on and saturate. As Q315 saturates, the collector potential goes positive and approaches the supply voltage (from the emitter of Q315). The supply voltage is now applied to the alert light and the light turns on.

NOTE

Once the decoder has been activated, voltages for bi-stable transistors Q311 and Q315, and the squelch switch control transistor Q306 remain in their activated condition until manually reset by the reset switch.

Transistor Q315 also provides a positive voltage to connector P1-1 to activate the relay switching kit (if used) when the decoder is alerted.

The positive change in the collector potential of Q315 is also applied through resistor R314 to the base of Q306, the squelch switch control transistor. Transistor Q306 will, in turn, saturate, causing its collector to go to ground potential. With the collector at ground potential, P1-3 applies a ground to J1-3. With a ground at J1-3, the circuit for the squelch switch stages is completed. Since a signal is being received at this time, the squelch switch stage will be in an unsquelched condition, which turns on the audio circuit by forward biasing the audio preamplifier, audio driver, and power amplifier transistors.

As the collector of Q309 goes positive, power is applied to the collectors of transistors Q313 and Q316. Transistors Q313 and Q316 form an alert tone oscillator stage which oscillates at approximately 2000 cps. The oscillator is a very stable circuit using two transistors arranged as a Darlington pair driving a parallel "Twin-T" RC network. A phase shift of 180° is achieved across transistor Q316 and an additional 180° phase shift occurs across the "Twin-T" network. The output of this network is applied as positive feedback to the input of Q313 to sustain oscillations. The alert tone is coupled through C321 to one of three voltage divider networks. The voltage divider network is selected by jumper JU1 being placed to J1 for a high level of 2 watts, to J2 for a medium level of 500 milliwatts, or to J3 for a low level of 50 milliwatts. The alert tone signal from the voltage divider network appears at P1-6, to J1-6 on the receiver board, and finally at the input to the audio preamplifier where it is amplified and coupled through the remaining stages to the speaker.

Transistor Q318, an audio mute stage, is also controlled by the output of transistor Q309. As Q309 saturates, the positive going voltage on its collector is coupled through resistor R336 to the base of Q318. Since Q318 is a P-N-P transistor, the positive-going voltage on its base cuts it off. In the receiver, the audio path is from the volume control to J1-7, through the cabling to P1-7 on the decoder board, through C324 and Q318 to P1-6, and through the cabling to J1-6 and the audio stages of the receiver. With Q318 cut off and the audio path blocked, tone B is prevented from reaching the speaker during the time that the alert tone is generated. After tone B stops, Q318 again conduct again establishing the audio path.

During the reception of tone B, the multivibrator circuit will return to its former state (Q314 cut off, Q317 conducting). The collector of Q314 will go positive, applying a positive potential to the base of clamp stage Q312. However, the reverse bias condition established by the conduction of Q309 exceeds the positive base potential and the clamp stage is kept in its cut-off state for the remainder of the tone B transmission. At the end of the tone B transmission, the clamp stage will again conduct, cutting amplifier Q304 off and deactivating the trigger and tone oscillator circuits.

The visual indicator "A" stays illuminated until the RESET switch is momentarily actuated. When this occurs bi-stable transistors Q311 and Q315 revert to their original state. Consequently, Q306 is cut off, thereby deactivating the noise squelch gate and muting the audio stages. The receiver may now be activated again by the correct sequential tones.

NOTE

The alert tone will be heard if the signal is repeated even if the unit has not been reset.

c. Monitor Selection and Tone Identification

(1) Monitor Selection

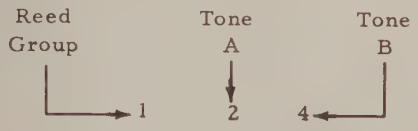
In systems using a pushbutton control console (or more than one console), the operator selects the console corresponding to the first digit of the monitor code and then pushes the buttons corresponding to the second and third digits of the code.

In dial control systems with a capacity of 90 monitors (or less), the second and third digits of the code are dialed to alert the monitor. In dial control systems employing more than 90 monitors, the complete three digit code must be dialed.

(2) Tone Identification

The three digit monitor code identifies a specific reed group assigned to the receiver and the two tone frequencies (A and B) used for the alerting circuit. The first digit identifies the reed group. The second and third digits determine tone frequencies A and B used in that particular group. In systems employing pushbutton consoles, only the four reed groups listed in Chart A are used.

Using Chart A and assuming that the monitor code is 124, the reed group is determined by correlating the first digit of the monitor code 1 to the reed groups listed in Chart A. For monitor code 124, the reed group assigned to the alert monitor would be reed group 1. The frequency tones A and B used within this group are determined in a similar manner except that the Tone Code column of Chart A is used to correlate the second and third digits of the monitor code. The second digit of the code (2) is Reed Code 112 with a frequency of 368.5 Hz (under the Reed Group 1 column) and the third digit is Reed Code 114 with a frequency of 410.8 Hz.



In dial control systems, combinations of the four reed groups are used in addition to the standard four groups to obtain additional call capacity. To identify the tones used in these systems, proceed as follows:

Assume the monitor code is 324. Locate first digit (3) in Chart B under the heading Code Group. In the second and third columns of this chart are the digits 1 and 2. These digits identify the reed groups (see Chart A) from which Tone A and Tone B were selected. In the above example, Tone A is the second tone in Reed Group 1 (reed 112) which is 368.5 Hz. Tone B is the fourth tone in Reed Group 2 (reed 124) which is 707.3 Hz. This method may be used to determine the tone frequencies of the monitor.

Early versions of Motorola selective calling control equipment used a code consisting of four digits. To make this equipment compatible with two-tone sequential monitors, simply drop the third digit. Example: Code 2527 uses the same reed coding as Code 257 and contains reeds 125 and 127. When the third digit is dropped the tones used can be determined by the method outlined in the previous paragraphs.

CHART A

Tone Number	Reed Group 1		Reed Group 2		Reed Group 4		Reed Group 5	
	Reed Code	Freq.	Reed Code	Freq.	Reed Code	Freq.	Reed Code	Freq.
1	111	349.0	121	600.9	141	339.6	151	584.8
2	112	368.5	122	634.5	142	358.6	152	617.4
3	113	389.0	123	669.9	143	378.6	153	651.9
4	114	410.8	124	707.3	144	399.8	154	688.3
5	115	433.7	125	746.8	145	422.1	155	726.8
6	116	457.9	126	788.5	146	445.7	156	767.4
7	117	483.5	127	832.5	147	470.5	157	810.2
8	118	510.5	128	879.0	148	496.8	158	855.5
9	119	539.0	129	928.1	149	524.6	159	903.2
0	110	330.5	120	569.1	140	321.7	150	553.9

CHART B

Code Group	Reed Group From Which Tone A is Selected	Reed Group From Which Tone B is Selected
1	1	1
2	2	2
3	1	2
4	4	4
5	5	5
6	2	1
7	4	5
8	5	4
9	2	4
0	4	2

CHART C

Reed No.	Freq.
109	313.0
130	979.0
131	1034.7
139	304.7
160	953.7
161	1006.0
162	1063.2

Chart C lists seven additional reeds which can be used in spare monitors used with dial control systems. The code of a spare monitor will have the same second and third digits (e.g. 322). The frequency of Tone A is determined by the method described previously. However, Tone A is selected from the seven frequencies listed in Chart C. The frequency of Tone A is determined by the available tone and is assigned by Motorola to the system.

5. "QUIK-CALL" DECODER UNIT

(Refer to "Quik-Call" Decoder Schematic Diagram)

a. General

The "Quik-Call" decoder is a selective signalling device that responds to the proper arrangement of four individual tones for individual call operation. The four tones are arranged in two groups with two tones assigned to each group. Each tone has its own tone circuit and when the proper sequence of tones are received a control circuit is actuated. The control circuit illuminates the "A" visual indicator (red alert lamp), controls the squelch switch stages in the receiver, and activates the alert tone oscillator. The decoder can also be used for group call operation. In this case, a single pulse of two simultaneous tones initiates the same functions as for the individual call operation. The decoder connects to the receiver through a seven-conductor cable.

b. Individual Call Operation

When a signal, modulated by the proper audio tone frequencies, is received at the receiver the recovered audio tones at the receiver discriminator are applied via J1-4 and the intercabling to P1-4. The tones are then coupled to the base of transistor Q200, an N-P-N emitter follower stage. This stage provides a high impedance input and isolates the decoder to prevent loading of the discriminator.

An output from the emitter of Q200 is direct coupled to the base of transistor Q201, a P-N-P tone amplifier stage. The tone signals are amplified and appear across the collector loads of Q201 which consists of the input coils of all four "Vibrasponder" reeds in series. When a tone corresponding to the resonant frequency of a "Vibrasponder" reed is applied to its input, that particular reed will pass the frequency to its output coil.

Transistors Q200, Q201, Q202 and Q210 derive their voltage from a zener regulator source (7.5V) to control the deviation overdrive and the gain of the stages used for Reed Tones 1 and 2. This, in conjunction with the time period during which an on-frequency tone must be present to activate the trigger circuit, reduces the chance of falsing caused by random noise impulses or voice energies of the proper frequency.

Transistors Q202, Q210, Q213 and Q215 are tone amplifiers operated class "A" and amplify outputs from the respective reeds. Tones 1 and 2 are received first and appear simultaneously at the inputs to the "Vibrasponder" reeds. The outputs from "Vibrasponder" reeds 1 and 2 are coupled to the bases of tone amplifiers Q210 and Q202, respectively. The amplified signals are coupled by capacitors C211 and C205 to the bases of transistors Q211 and Q203 respectively. Q211 and Q203 are both driven into saturation by the incoming tone signal. This drops the collector voltage of Q211 to ground potential. As this occurs, the base of Q204 also moves in a negative direction causing a forward bias condition to be established for the base-emitter junction of Q204, which turns on and saturates. When this occurs, the collector voltage of Q204 swings positive to nearly the A+ potential. As the collector voltage of Q204 goes positive, capacitor C207 charges to the A+ potential and the base of transistor Q205 swings positive. This would normally forward bias Q205 and cause it to turn on. However, during this sequence there is no ground return path for the emitter of Q205 and the transistor remains inactive. The conditions just described remain as long as tones 1 and 2 are present.

When tones 1 and 2 cease, all circuits revert to the standby status, except the base voltage of transistor Q205 which remains positive due to the charge on capacitor C207. As soon as tones 1 and 2 cease and transistor Q204 turns off, capacitor C207 starts to discharge and the voltage at the base of Q205 begins to decrease toward ground potential. For the decoder to be activated, tones 3 and 4 must be received before the base voltage of Q205 decreases to a level inadequate for the turn-on of Q205.

Tones 3 and 4 are received approximately 0.2 seconds after tones 1 and 2. These tones are coupled through J1-4 and the intercabling to P1-4 on the decoder and to Q200 which in turn feeds a signal to Q201. Transistor Q201 amplifies the signals which appear across the inputs to "Vibrasponder" tone reeds 3 and 4. The outputs produced by these reeds are amplified by transistors Q215 and Q213, and are coupled by capacitors C217 and C214 to transistors Q216 and Q214, respectively.

The latter two stages are saturated by the signals causing the collector potential of Q214 to decrease to near ground potential. With the collector of Q214 at ground potential, diode CR202 becomes forward biased and establishes a ground return for the emitter of Q205. Diode CR202 prevents the A+ potential from being applied to the emitter of Q205 during standby so that excessive reverse bias will not damage the transistor. Since capacitor C207 has not completely discharged, the base of Q205 is still positive causing transistor Q205 to saturate.

As soon as transistor Q205 saturates, its collector potential decreases toward ground potential, causing the base of transistor Q206 to swing in the negative direction. The PNP transistor (Q206) starts to conduct which, in turn, applies a forward bias to diode CR206. With diode CR206 forward biased, a positive pulse is applied to bi-stable, transistors Q207 and Q208.

NOTE

Once diode CR206 is forward biased by the positive voltage at the collector of Q206, all voltages established beyond the cathode side of the diode are alert readings. These readings are maintained until the RESET switch is actuated. When the bi-stable is in the alert condition (actuated), diode CR206 is reverse biased by the bi-stable, thereby preventing current flow from the bi-stable to ground via resistor R215.

As the positive pulse from diode CR206 is applied to the base of transistor Q207, the base-emitter junction becomes forward biased and the transistor turns on. The collector voltage of Q207 decreases to ground potential, causing the base voltage of Q208 to swing in a negative direction. Q208, a PNP transistor, is forward biased by the negative going voltage on its base. When Q208 conducts, its collector voltage is applied through resistor R221 as positive feedback to the base of Q207, keeping Q207 conducting. With Q207 conducting, the bi-stable (Q207 and Q208) is held to its present state (locked on).

The positive potential at the collector of Q208 is also applied to diode CR201. CR201 becomes forward biased and allows a positive voltage to be applied to resistor R222 and lamp DS200. At this time, the lamp turns on and remains on until the circuit is manually reset by the RESET switch. CR201 prevents the A+ potential from being applied to the collector of Q208 during manual reset. If A+ were to reach this point, the alert tone oscillator would be activated.

At the same time, the positive voltage from the collector of Q208 is applied through diode CR201 and resistor R224 to the base of transistor Q209, forward biasing the transistor and turning it on. As Q209 conducts, its collector voltage decreases to ground potential. The ground potential applied via P1-3, the intercabling and J1-3 completes the circuit for the squelch switch stages of the receiver. Since a signal is being received, the squelch switch stages now activate the audio stages. Transistor Q208 also provides a positive voltage through diode CR201 to P1-1 to activate the relay switching kit (if used) when the decoder is alerted.

A final output from transistor Q208 (point C on the diagram) applies a positive voltage to the alert tone oscillator (Q219 and Q220) and to alert tone timing transistor Q218. The oscillator is a very stable "Twin-T" circuit utilizing two transistors arranged as a Darlington pair driving a parallel "Twin-T" RC network. A phase shift of 180° is achieved across transistor Q220 (no phase shift across Q219) and an additional 180° phase shift occurs across the "Twin-T" network. The output of the RC network is applied as positive feedback to the base of Q219 to sustain oscillations.

Once voltage has been applied to the collectors of the transistors, an alert tone is applied from the collector of Q219 through resistors R250 and R251 to P1-6, through the intercabling to J1-6 and then to the audio stages where it is amplified and applied to the speaker. Three levels of tone output are available by connecting JU1 to J1 for a 2-watt or to J2 for a 500-milliwatt output, or to J3 for a 50-milliwatt output.

While the alert tone oscillator is operating, the paging tones are blocked from reaching the receiver audio stages by blocking diode CR205.

The path for receiver audio is from the volume control to J1-7, through the intercabling to P1-7, through capacitor C228 and diode CR205 to P1-6, through the intercabling to J1-6, and into the input of the audio preamplifier stage. As voltage is applied to the alert tone oscillator, a voltage is applied through resistors R250 and R251 to the cathode of diode CR205, making the cathode more positive than the anode. Thus, the receiver diode is reverse biased and the audio path is effectively open.

The alert tone oscillator is on for approximately 3 seconds. This is controlled by the time constant associated with R241, R242, and C222. When voltage is applied to point C from the collector of Q208, the alert tone oscillator immediately starts oscillating. However, alert tone timing transistor Q218 does not start to conduct due to capacitor C222 in

its base circuit. When the voltage from point C is first applied, C222 is effectively a short circuit to ground, keeping Q218 cut off. The capacitor will start to charge through R241 and R242. After approximately three seconds, the charge of C222 is sufficient to forward bias the base-emitter junction of Q218 causing it to conduct. The collector voltage of Q218 decreases to ground potential, removing the voltage applied to the alert tone oscillator. At this time, the alert tone oscillator will cease operating and CR205 again becomes forward biased. The conditions as now exist remain until the RESET switch is operated. Diode CR204 provides a fast discharge path for capacitor C222 after the voltage has been removed, setting up the decoder for the next alerting signal.

Transistor Q212 provides protection against falsing (response to an improper combination of tones) if the tones are presented in the reverse order. If tones 3 and 4 appear before tones 1 and 2, the reception of tones 3 and 4 causes the collector of Q214 to decrease to a ground potential. This results in a negative-going voltage being applied to the base of transistor Q212 and establishes a forward bias for the base emitter junction. Transistor Q212 turns on and its collector voltage rises to the emitter voltage or A+ potential. The collector of Q212 is tied to the base of Q204 and the presence of an A+ potential produces a reverse bias condition for transistor Q204. Since Q204 cannot turn on transistor Q205 will not be activated even though the emitter of Q205 has been placed at ground potential by turning on Q214. When tones 3 and 4 cease, Q212 stays on for approximately one second due to the charging of capacitor C215 through R233 and its parallel path of R229 and the base-emitter junction of Q212. Now, when tones 1 and 2 appear, transistor Q204 cannot turn on since its base is still held at A+ potential. Thus, the decoder is not activated.

c. Group-Call Operation

To alert a number of receivers simultaneously, the associated base transmitter sends a group call code consisting of a single pulse of two simultaneous tones (tones 2 and 3). The tone modulated signal and the audio tones are recovered in the receiver discriminator. The signals are applied via J1-4 and the intercabling to P1-4, the input to the decoder board. Again, as in individual call operation, the input signals are coupled to emitter-follower stage Q200 which in turn feed signals to Q201, the tone reed amplifier.

In the collector circuit of Q201, the input coils of the "Vibrasponder" tone reeds 2 and 3 will couple tones 2 and 3 to the respective output coils. Tones 2 and 3 are now coupled to tone amplifiers Q202 and Q215 respectively. The output from transistor Q202 would normally (in individual call operation) turn on Q203. However, since tone 1 is not present, Q211 is not turned on and Q203 cannot be turned on since its emitter circuit is not completed. Instead, an output from the collector of Q202 (point "B" on the diagram) will apply tone to the base of Q217 in order to activate this transistor instead of Q203.

Meanwhile, tone 3 has been amplified by Q215 and the output of Q215 has caused Q216 to turn on and saturate. The collector circuit of transistor Q216 is completed to ground, placing a ground on and completing the circuit of the emitter of Q217. With its emitter circuit complete and the tone 2 input on its base (point "B"), transistor Q212 turns on, (saturates) and its collector voltage decreases to near ground potential. With the collector of Q217 at ground, the base voltage of Q221 decreases toward ground potential as capacitor C230 begins to discharge through resistor R256, transistor Q217 (saturated) and transistor Q216 (saturated) to ground. Approximately 2.5 seconds after tones 2 and 3 begin, the voltage at the base of Q221 has decreased enough to allow Q221 to turn on.

Diode CR200 is used to bypass resistor R256 when the set is first turned on and applies A+ potential immediately to the base of Q221, preventing it from turning on and activating the decoder.

When Q221 turns on, its collector potential goes positive which applies a positive-going voltage to transistor Q222. Transistor Q222 saturates, causing its collector potential to decrease to ground causing the base of Q206 to move in a negative direction. Transistor Q206 will conduct, applying a positive pulse to its collector. This positive pulse causes transistors Q207, Q208 and Q209 to conduct, and keep the red A (alert) light on and the radio in the noise squelch (receiving all on-frequency messages) condition. This same positive pulse also triggers the automatically timed-out tone oscillator which provides the alerting tone of approximately 3 seconds duration. These conditions will remain until the RESET switch is manually operated.

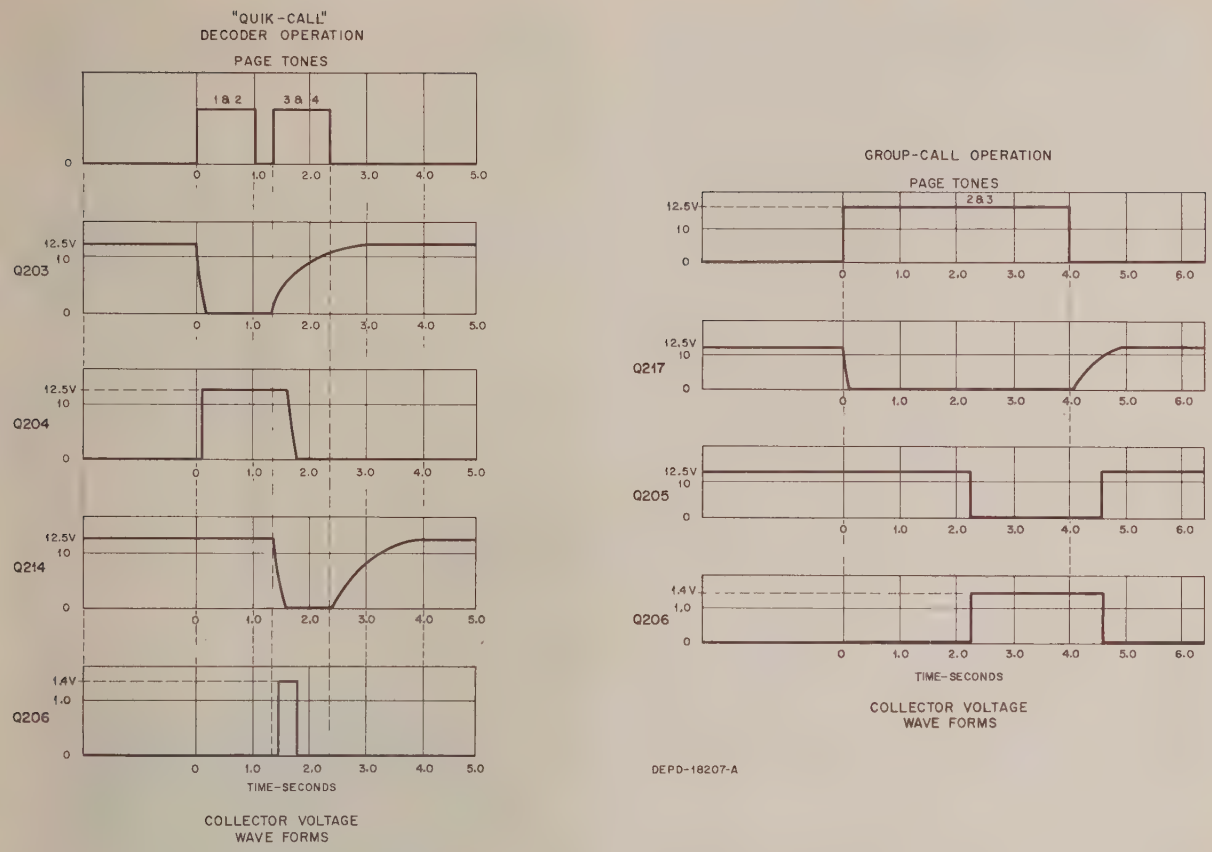


Figure 4.
"Quik-Call" Decoder Operation Waveforms

"VIBRASPONDER" REED FREQUENCIES AND DESIGNATIONS

CODE LETTER	FREQUENCY (HERTZ)	CODE LETTER	FREQUENCY (HERTZ)	CODE LETTER	FREQUENCY (HERTZ)
CZ	346.7	CB	371.5	CA	358.1
DZ	384.6	DB	412.1	DA	398.1
EZ	426.6	EB	457.1	EA	441.6
FZ	473.2	FB	507.0	FA	489.8
GZ	524.8	GB	562.3	GA	543.3
HZ	582.1	HB	623.7	HA	602.6
JZ	645.7	JB	691.8	JA	668.3
KZ	716.1	KB	767.8	KA	741.3
LZ	794.3	LB	851.1	LA	822.2
MZ	881.0	MB	944.1	MA	912.0
NZ	977.2	NB	1047.1	NA	1011.6
PZ	1084.0	PB	1161.4	PA	1122.1

6. "PRIVATE-LINE" TONE DECODER UNITS

a. General

The receiver discriminator output from P1-4 contains both voice and "Private-Line" tone. This output is applied to the input of an emitter-follower stage, Q401. The output of the emitter-follower is fed through an active low-pass filter which passes the "Private-Line" tone but does not allow a significant amount of voice energy to reach the limiter stage. This prevents the voice energy from capturing the limiter stage, which would cause the decoder to block. The "Private-Line" tone continues through an amplifier Q402 which drives the limiter circuit consisting of Q403 and Q404. The limiter Q404 has a low-value, unbypassed, emitter resistor which provides high input impedance for the stage. The stage gain of the limiter is approximately equal to the ratio of the value of the collector resistor to the value of the emitter resistor.

The output from the limiter (Q404) is coupled to the "vibrasponder" resonant reed by the capacitor C414 and a series resistor (R418), providing maximum drive to the reed. The drive is 6 db above its mechanical limiting level (twice the mechanical limiting voltage). The limiter begins to clip at 60% of the minimum "Private-Line" system deviation.

The output of the "Vibrasponder" resonant reed is applied to a single forced-gain amplifier stage (Q405) with the operating point stabilized by the compensating characteristics of diode CR401. The output from this amplifier stage is applied to the base of Q406, an emitter-biased detector stage, which senses the presence of a reed output. A dc bias voltage is applied to the emitter of Q406. When the signal on the base is of sufficient amplitude, the transistor conducts, providing a pulsed output. The collector load resistor has a high value for maximum gain. The base bias network contains a forward-biased silicon diode CR402 to compensate for the drop across the transistor base-emitter junction. With this device, the threshold level is held constant with variations in temperature and voltage. The output from the detector is passed to an emitter-follower stage (Q407) with a capacitive load. This capacitive load achieves an impedance match and filters the pulses from the detector.

The setting of resistor R426 determines the dc voltage applied to the emitters of Q406 and Q408. This setting determines the decoder sensitivity (threshold of operation). The voltage difference between the emitters of Q406 and Q408 is held as small as possible, without impeding circuit operation, to eliminate a long "squelch tail" which which would otherwise result from the discharge time related to C418, R433, and R435. The magnitude of the dc voltage on the emitter of the detector (Q406) determines the magnitude of the signal necessary to turn Q406 on.

Transistors Q408, Q409 and Q410 comprise a monostable multivibrator circuit. When the correctly-coded tone is detected, Q407 will turn on and apply a positive voltage to the base of Q408. Q408, Q409 and Q410 turn on and as Q410 conducts, its collector voltage approaches ground potential, placing a ground on terminal P1-3. With a ground on this terminal, the audio stages in the receiver become forward biased and audio is heard at the speaker.

Since a low-pass filter restricts the bandwidth of noise which can drive the "Vibrasponder" resonant reed when no signal is received, the decoder could falsely respond to noise pulses (noise falsing). To prevent noise falsing, some high-frequency noise is shunted around the low-pass filter to reduce the noise from the limiter at the "Vibrasponder" reed frequency. When a correctly-coded signal is received diode CR403 is forward biased, and the high-frequency components are removed.

A high-pass filter is inserted between the discriminator and the audio preamplifier (at P1-7 to P1-6) to prevent the "Private-Line" tone frequencies from reaching the audio output.

When the "Private-Line" current is in operation A+ voltage is applied to the base of Q18, the receiver squelch switch, to disable the noise squelch circuitry.

b. Tamper-Proof "Private-Line" Decoder

The circuitry enclosed by a dashed outline on the schematic diagram is included in tamper-proof decoders only. Noise squelch circuitry is not used in these models. Transistor Q413 and capacitor C424 make up a capacitor multiplier. This multiplier requires the voltage at the emitter of Q407 to be positive from 0.5 to 1.5 seconds before transistor Q415 can turn on, to turn on the alert light. With this arrangement, a short noise burst, 100-150 milliseconds duration, will not activate the alert light. The negative slope of the C418 discharge is sensed by Q414, which turns on, and discharges C424. This prevents a charge from accumulating across C424 from successive noise bursts, with subsequent triggering of the alert light.

Once the base voltage of Q415 is raised to a sufficient level, the bistable multivibrator (Q415 and Q416) turns on and remains locked up. This turns on the alert light (DS401) to indicate that a message has been received.

"PRIVATE-LINE" REED FREQEUNCIES AND DESIGNATIONS

CODE NUMBER	FREQUENCY (Hz)	CODE NUMBER	FREQUENCY (Hz)	CODE NUMBER	FREQUENCY (Hz)
YZ	82.5	2Z	110.9	4B	146.2
YA	85.4	2A	114.8	5Z	151.4
YB	88.5	2B	118.8	5A	156.7
ZZ	91.5	3Z	123.0	5B	162.2
ZA	94.8	3A	127.3	6Z	167.9
ZB	98.1	3B	131.8	6A	173.8
1Z	100.0	4Z	136.5	6B	179.9
1A	103.5	4A	141.3	7Z	186.2
1B	107.2			7A	192.8

MAINTENANCE

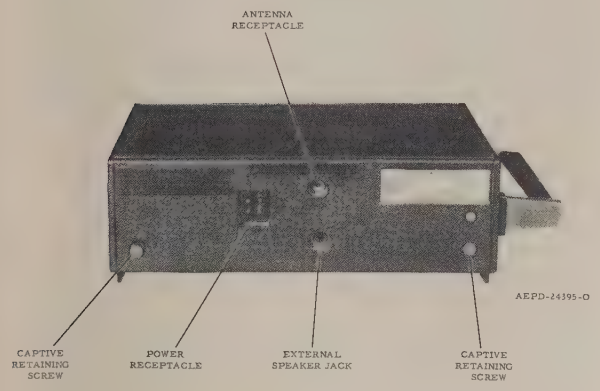


Figure 5. Rear View of Receiver

1. DISASSEMBLY PROCEDURES

a. Removal of Receiver from Housing (Figure 5.)

To remove the receiver from the housing, disconnect the power cord from the receptacle on the rear of the receiver. Remove the antenna connector from the chassis receptacle. Disengage the two captive retaining screws in the back panel of the cabinet by turning counterclockwise until they are free of the radio chassis. Slide the chassis forward and out of the housing.

b. Removal of Tone Decoder Board

To dismount the tone decoder board from the chassis of a selective call model, remove the four retaining screws located in each corner of the board. Lift the board up and slightly rearward until the front panel switches and switch bracket clear the lip of the front panel. For alignment purposes, leave the interconnecting cable wires plugged to the main circuit board pins.

If the interconnecting cable wires are disconnected for any purpose, they may be reconnected by matching the numbers on the wires to the corresponding pin numbers on the chassis.

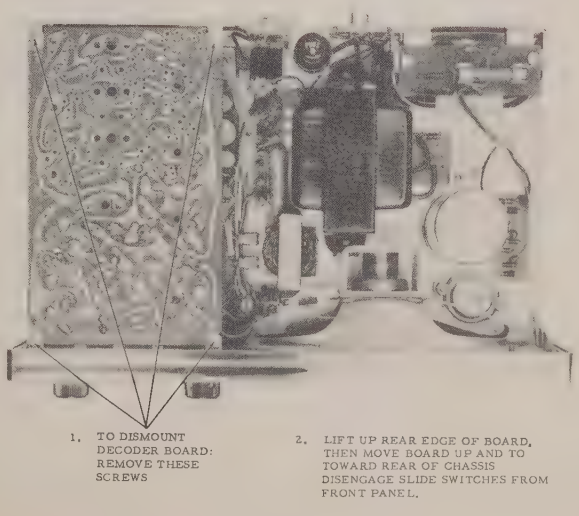

1. TO DISMOUNT DECODER BOARD: REMOVE THESE SCREWS
2. LIFT UP REAR EDGE OF BOARD, THEN MOVE BOARD UP AND TO TOWARD REAR OF CHASSIS DISENGAGE SLIDE SWITCHES FROM FRONT PANEL.

Figure 6. Tone Decoder Mounting Details

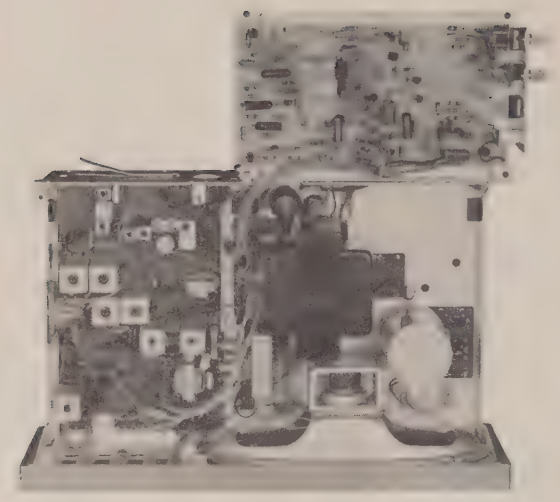


Figure 7. Decoder Board Swung Out for Access to Main Board

2. PERFORMANCE CHECKS AND TROUBLESHOOTING

a. Receiver

(1) RF and IF Stages

A 20 db quieting sensitivity check may be used to evaluate overall performance of these stages. If this check indicates that the receiver is not operating properly, stage gain and ac (rf) signal voltage measurements can be used to isolate the defective stage. When the stage is located, dc voltage and resistance measurements can be used to locate the defective component. After repair, the 20 db quieting check should again be performed to determine if realignment is required.

The 20 db quieting check is outlined in step-by-step form later in this section of the manual. Charts containing rf measurement information are also included. The schematic diagram contains dc voltage readings at pertinent points. Refer to the measurement charts for input information and normal signal levels.

(2) Audio Stages

A step-by-step procedure in chart form is included in this section of the manual for use in determining whether the receiver is delivering the full rated audio output. If this check indicates improper operation, ac signal measurements can be used to isolate the defective stage and dc voltage and resistance measurements can be used to determine the defective component

A chart containing normal ac signal measurements is also included. These readings are shown on the schematic diagram also but the chart should be referred to for signal input information and measurement techniques. Refer to the schematic diagram for dc voltage readings.

b. Decoders

A procedure for checking decoder operation using an oscilloscope is also included in chart form. Proper waveforms are shown on the schematic diagram and the corresponding physical observation points are shown on the respective printed circuit board detail. If improper waveforms or improper decoder operation are encountered, refer to the Theory of Operation section for details of operation and the respective schematic diagram for dc voltage measurements.

OVERALL RF & IF PERFORMANCE CHECK

(20 db Quieting Sensitivity)

Test Equipment Required:

(1) Motorola S1319A Signal Generator or equivalent.
(2) Motorola SKN 6015A RF Adapter Cable
(3) Motorola S1056A-9A Portable Test Set or ac voltmeter

STEP	PROCEDURE
1	Connect signal generator to antenna receptacle (use adapter cable). Connect test set to metering receptacle or connect ac voltmeter across speaker voice coil.
2	Turn radio set on and turn squelch control fully counterclockwise (maximum noise). If test set is used, place SPKR switch in OPEN position and position selector switch in position II AUDIO.
3	With no output from signal generator, adjust volume control on receiver for reading of 1.4 v ac on test set (0-2) or ac voltmeter.
4	Hold test set multiplier switch in 0.2 v ac position and increase signal generator output (carrier frequency without modulation) until test set (or ac voltmeter) reads 0.14 volt. NOTE If ac voltmeter is used, volume control may be adjusted for any convenient reading in Step 3 and signal generator output adjusted for 1/10 of that reading in this step.
5	Read microvolt input on signal generator attenuator. This reading (20 db quieting sensitivity) should be less than 0.7 microvolt.

EPD-24474-O

AUDIO PERFORMANCE CHECK

(Full Rated Audio Output)

Test Equipment Required:

(1) Motorola S1319A FM Signal Generator, or equivalent.
(2) Motorola SKN6015A RF Adapter Cable
(3) Motorola Solid-State AC Voltmeter, or equivalent.

STEP	PROCEDURE
1	Apply a 1000-microvolt carrier frequency signal to external antenna receptacle.
2	Set modulation selector switch (MOD) to 1000 (Hz). Adjust deviation control (DEV) for 3.3 kHz on meter.
3	Set volume control on receiver to maximum and squelch control to minimum.* Measure ac voltage across speaker voice coil or from "hot" side of external speaker jack to ground. The ac voltmeter should indicate 2.53 volts for fully rated audio output.

*Procedure produces 2-watt audio output (high sound level). Speaker may be disconnected and resistor of similar value (approximately 3.2 ohms) connected in its place. If receiver is equipped with a decoder, place MON-ALERT switch in MON position.

EPD-21034-A

AUDIO AMPLIFIER MEASUREMENTS

Test Equipment Required:

(1) Motorola TEK-1A Tone Generator (1000 Hz) or equivalent.
(2) Motorola Solid-State AC Voltmeter or equivalent.

1000 Hz INPUT		OUTPUT		
APPLIED AT	LEVEL	MEASURED AT	AC READING	REMARKS
J1-6 on Receiver Board	4.2 Millivolts	Speaker	.34 v (-7 dbm)	Remove jumper between J1-6 and J1-7 on receiver board while making measurements.
		Q12 Collector	.42 v (-5 dbm)	
		Q12 Base	3.4 mv (-47 dbm)	
		Q11 Emitter	3.9 mv (-46 dbm)	
		Q11 Base	4.0 mv (-45.5 dbm)	
	35 Millivolts	Speaker	2.53 v	
		Q13 Collector	8.0 v	
		Q13 Base	0.75 v	
		Q12 Collector	2.0 v	

EPD-21035-A

DECODER TROUBLESHOOTING PROCEDURE

Test Equipment Required:

(1) Motorola S1319A FM Signal Generator, or equivalent.
(2) Motorola SKN6015A RF Adpater Cable.
(3) Motorola TEK-34A Universal Tone Generator, or equivalent.
(4) Motorola S1302A Osilloscope, or equivalent.
(5) Motorola Solid-State DC Multimeter, or equivalent.

STEP	PROCEDURE
1	Inject a 1000-microvolt carrier frequency signal at external antenna receptacle.
2	Set modulation selector switch (MOD) on signal generator for external (EXT) modulation. Connect tone generator to external modulation terminals of signal generator and with correct tone(s) applied, adjust to rated deviation.
3	Refer to applicable schematic diagram for waveform information and printed circuit detail for observation points and compare waveforms.
4	If waveforms observed are incorrect, refer to schematic diagram and use dc voltage and resistance measurements to locate defective component.

EPD-21036-A

3. ALIGNMENT PROCEDURES

a. Basic Receiver

For details of alignment and metering points, refer to Receiver Alignment Procedure PEPD-24397. Test equipment required and oscillator crystal frequencies are also included.

b. Model NLN1046A Single-Tone Decoder Unit

(1) Test Equipment Required

Motorola Transistorized AC Voltmeter
Motorola DC Multimeter
Motorola FM Signal Generator
Motorola S1067A Audio Oscillator
Motorola S1302A Wideband Oscilloscope
Motorola S1075B Digital Frequency Meter

(2) Alignment Procedure

(a) Connect the receiver to 117 volts ac, using the line cord supplied with the receiver.

(b) Connect the signal generator to the receiver antenna input using the SKN6014A RF Adapter Cable.

(c) Set the signal generator to the assigned receiver frequency by monitoring the discriminator output (at metering point T5-4) with a dc voltmeter for a zero reading. Adjust the rf level to 1 millivolt.

(d) Set the audio oscillator to the assigned decoder frequency with the frequency counter.

(e) Modulate the signal generator at 3.3 kHz deviation with the output of the audio oscillator.

(f) Connect the ac voltmeter to metering point M101 (tan) on the decoder board and adjust the pot core tuning slug for maximum voltage (not to exceed +6 dbm which is equivalent to 1.53 volts ac). If the reading exceeds this value, reduce it by adjusting resistor R109.

(g) With the decoder in final position firmly mounted on the receiver, adjust R109 for a +4.6 dbm which is equivalent to 1.3 volts ac reading at the metering point.

(h) With the audio oscillator set to the decoder frequency, check the alerting sensitivity of the unit by reducing the rf level into the unit until the unit will no longer respond to the alert. The lowest value of rf input at which the decoder will still respond to the alerting tone is its alerting sensitivity. The alerting sensitivity should be not more than 0.25 microvolt.

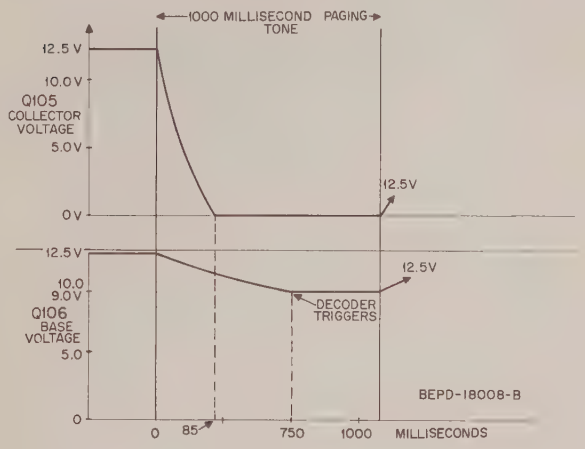


Figure 7.
Typical Operation During
1.0 Second Alerting Tone

NOTE

The transmitter single-tone encoder must produce 3.3 kHz deviation for proper operation of the receiver single-tone decoder. Transmitter deviation less than 3.3 kHz will result in degradation of decoder bandwidth. Deviation greater than 3.3 kHz will reduce the available amount of protection against voice and noise falsing operation.

c. Model NLN6577A "Quik-Call" Decoder Unit
Model NLN6578A Two-Tone Sequential Decoder Unit

These decoder units require no special alignment procedures. For voltage readings, refer to the appropriate schematic diagram. For waveform details, refer to the THEORY OF OPERATION.

d. Model NLN6648A Standard Version "Private-Line" Decoder, Model NLN6649A "Tamper-Proof" Version Private-Line Decoder

(1) Refer to b (1) for required test equipment.

(2) Alignment Procedure

(a) Set FM signal generator to 1 mv and zero the discriminator.

(b) Rotate decoder sensitivity control (R426) to full ccw position.

(c) Modulate signal generator at reed center frequency.

(d) Connect volt meter to base of Q405 and adjust deviation to produce a limiting level at this point. (AC voltage at Q405 base stops increasing as deviation is increased further.)

(e) Decrease the generator deviation until the base voltage of Q405 drops 5 db. Under these conditions, rotate R426 cw until the dc voltage at J1-3 just drops to zero.

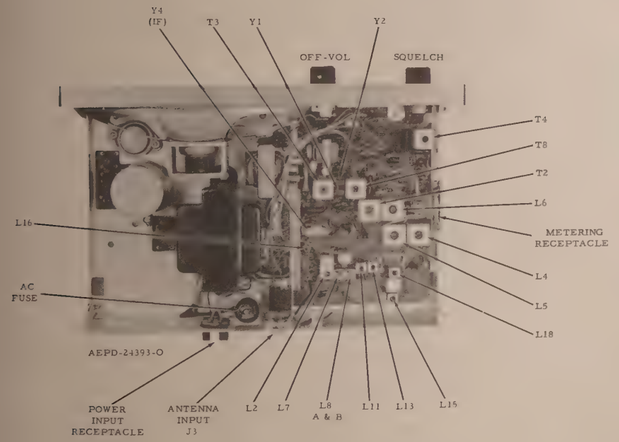
TEST EQUIPMENT REQUIRED FOR RECEIVER ALIGNMENT

1. Motorola FM Signal Generator or equivalent.
2. Motorola Model S1056A-9A Series Test Set with 455 kHz crystal or equivalent crystal oscillator.
3. Motorola Model NKN6131A Antenna Adapter Cable.
4. Motorola Model NLN6598A and NLN6634A Alignment Tool (supplied).
5. Motorola Model S1078C Digital Frequency Meter and Deviation Monitor.

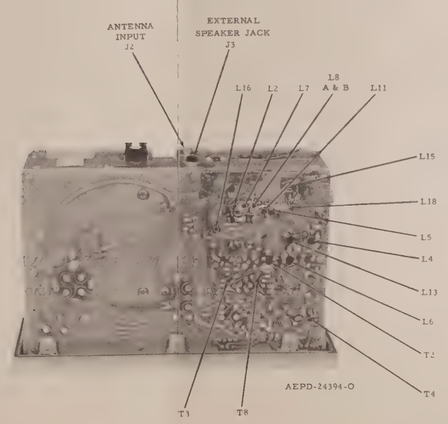
PRELIMINARY SET-UP FOR RECEIVER ALIGNMENT

1. Remove receiver from housing by loosening the two captive screws on the rear of the radio case, then withdrawing the chassis.
2. Set all coil slugs flush with top of coil forms, as viewed from solder side of circuit board, except L4, L5, L6, T2 and T4.
3. Connect radio to 117 volt ac or to +13.8 volt dc supply. Turn on receiver, and set SQUELCH control for maximum noise (control fully counterclockwise).
4. If radio is equipped with tone decoder, set MON-ALERT switch to MON position.
5. Connect signal generator to antenna receptacle.

CARRIER FREQ. MHz	SECOND OSCILLATOR CRYSTAL FREQ. MHz
450-470	15.890
406-420	15.890

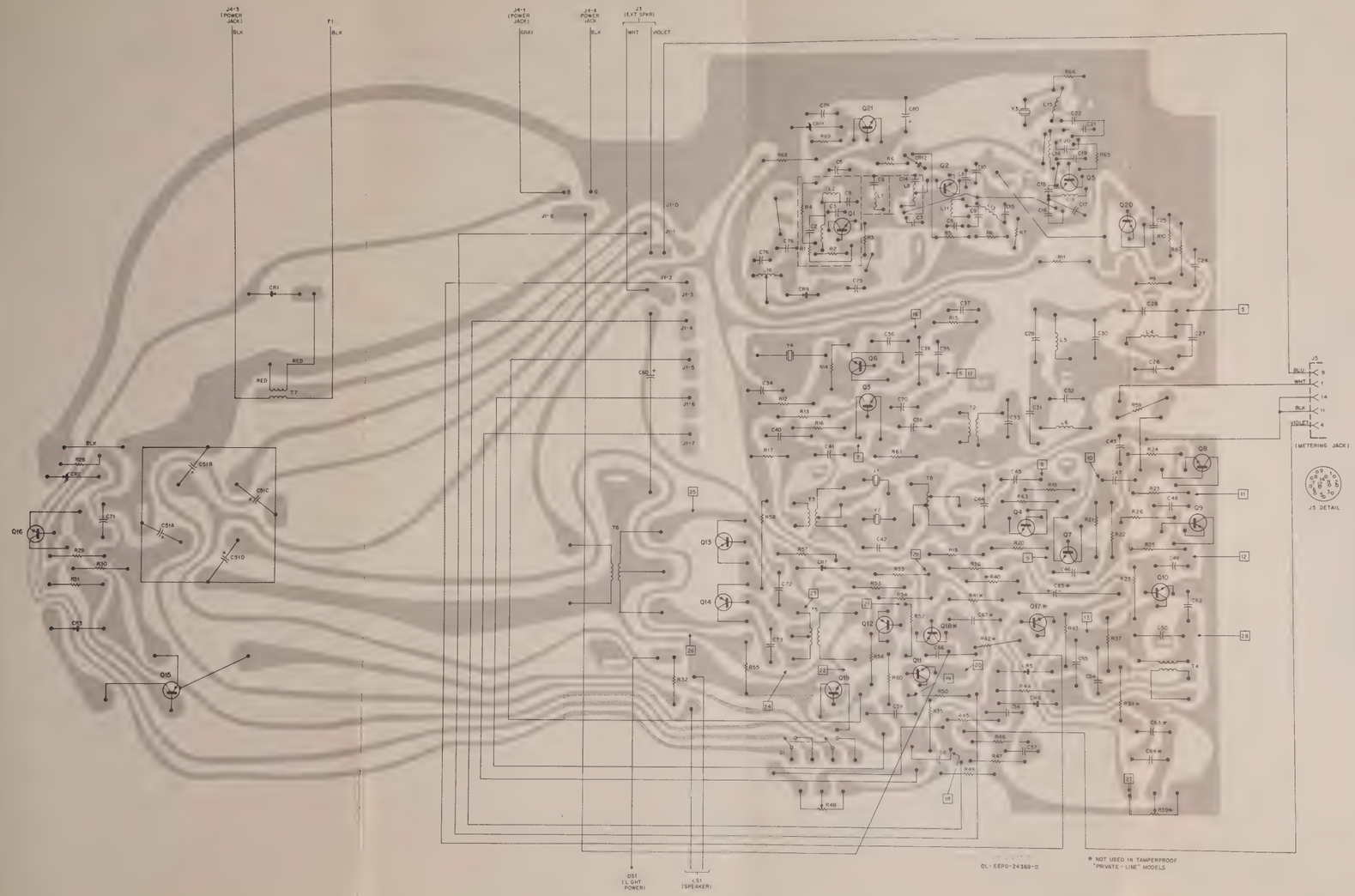


Metering and Alignment Points

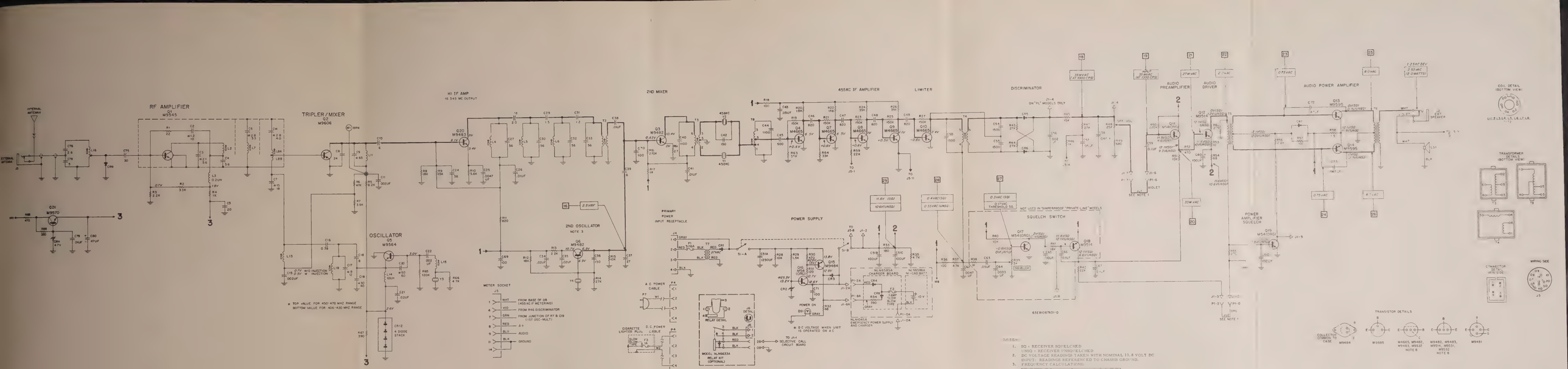


ALIGNMENT PROCEDURE

STEP	TEST EQUIPMENT	TEST SET METER POSITION	ADJUSTMENT	PROCEDURE
1	Test Set	4	T4 Limiter/ Discriminator	Turn the unit off and note the deviation from center scale zero. Turn the unit on and connect 455 kHz output to base of Q4. Tune T4 to this reference on test set meter. Adjust slug for this reference nearest top of T4 as viewed from component side of board.
2	FM Signal Generator Test Set	1	L4, L5, L6, T2	Place test set in METER REVERSE position. If a signal at carrier frequency cannot be driven through receiver, inject 16.345 MHz signal at base of Q2. Adjust L4, L5, L6 and T2 for maximum dip. When meter passes through zero, reduce input signal level.
3	FM Signal Generator Test Set	4	Signal Generator	Connect signal generator to antenna input receptacle using SKN6015A RF Adapter Cable. Increase rf input from signal generator until receiver quiets, then adjust signal frequency for center scale zero on test set meter. Do not set generator frequency to 2nd i-f image frequency.
4	FM Signal Generator Test Set	1	T3, T8, L16, L2, L7, L8A&B, L11, L4, L5, L6, T2, L13, L18	Switch test set to METER REVERSE position. Tune each slug in succession for maximum dip on meter. When meter passes through zero, reduce level of input signal.
5	Base Station Transmitter Digital Frequency Meter/ Deviation Monitor Test Set	4	L15	With the base station transmitter or the digital frequency meter as a signal source at the carrier frequency, adjust L15 for a center scale zero reading on test set meter.
6	FM Signal Generator Test Set	11	Signal Generator Output	Set the SPEAKER control on the test set to OPEN. Turn the receiver squelch control fully counterclockwise. With no input signal, adjust the VOL control for a reading of 1.4 v ac on the 2 volt meter scale. With the test set meter range switch moved and held to the 0.2 VAC position, increase the rf output from the signal generator until the test set meter reads 0.14 volt on the 0.2 VAC range. Read the signal generator ATTEN control in microvolts. Reading should be less than 0.7 microvolt. This reading is the 20 db quieting level of the radio.



406-420 MHz & 450-470 MHz
Alert Monitor Receiver
Printed Circuit Board Detail
Motorola No. PEPD-24376-O



NOTES:

1. SQ = RECEIVER SQUELCHED
   UNSQ = RECEIVER UNSQUELCHED
2. DC VOLTAGE READINGS TAKEN WITH NOMINAL 13.8 VOLT DC INPUT; READINGS REFERENCED TO CHASSIS GROUND.
3. FREQUENCY CALCULATIONS:

406-420 MHz	450-470 MHz

4. UNLESS OTHERWISE STATED:
   ALL CAPACITANCES IN PICOFARADS (PF). SEE PARTS LIST FOR RESISTOR WATTAGE RATINGS.
5. REFER TO PARTS LIST FOR COMPONENT VALUE.
6. 1 / 1 ETC. REFER TO THE CORRESPONDING CIRCUIT BOARD DETAIL MEASUREMENT POINTS.
7. READING WITH NOISE INPUT ONLY (NO SIGNAL).

MODEL TABLE

MODEL NUMBER	SUFFIX	FREQ. RANGE MHz	DESCRIPTION
NBE6047AB		406-420	RECEIVER CHASSIS
NBE6048AB		450-470	RECEIVER CHASSIS
NBE6051AB		406-420	RECEIVER CHASSIS
NBE6052AB		450-470	RECEIVER CHASSIS
NKN4123A			AC POWER CABLE KIT
NKN4123A			DC POWER CABLE KIT

EPD-24371-O

PREVIOUS REVISIONS AND PARTS LIST SHOWN ON BACK OF THIS DIAGRAM

406-420 MHz & 450-470 MHz
Alert Monitor
Receiver Schematic Diagram
Motorola No. 63E81067A31-O
4/16/70-

PARTS LIST

NRE6047AB Receiver Chassis (406-420 MHz)
NRE6048AB Receiver Chassis (450-470 MHz)
NRE6051AB Receiver Chassis (406-420 MHz)
NRE6052AB Receiver Chassis (450-470 MHz) EPD-24529-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: pf ±5%; 500 v unless stated
C2	21D82450B38	1.2
	or21D82450B28	1 (406-420 MHz)
C3	21D82358G10	2.1 ±0.1 pf; 75 v; N150
	or21D82358G03	5.6 ±0.25 pf; 50 v; NP0 (406-420 MHz)
C4	21D82358G03	5.6 ±0.25 pf; 50 v; NP0
C5	21K861432	20 ±10%; 75 v; N150
C6	21D82877B08	2.8 ±0.25 pf; 75 v; N150
	or21D82358G01	3.3 ±0.25 pf; 50 v; NP0 (406-420 MHz)
C7	21D82877B19	15; 75 v; NP0
	or21D82877B46	18 ±10%; 75 v; N150 (406-420 MHz)
C8	21D82877B01	24 ±10%; 300 v; N750
C9	21D82358G14	65; 75 v; N080
C10	21K861428	6 ±10%; 75 v
C11, 22	21K861442	0.002 uf +100-20%; 75 v
C14	21D82877B08	2.8 ±0.25 pf; 75 v; N150
	or21K861427	4 ±10%; 75 v (406-420 MHz)
C15	21D82213E15	0.002 uf +100-20%; 50 v
C16	21D82450B21	0.34 ±10%
C17, 18	21K861429	8 ±10%; 75 v; N150
C19	21K864521	30 +30-10%; 75 v; N750
	or21K861434	40 ±10%; 75 v; (406-420 MHz)
C20	21D82358G15	50 ±10%; 100 v; N3300
	or21K864012	60 ±10%; 75 v; N150 (406-420 MHz)
C21	21D83068E01	0.02 uf ±20%; 12 v
C24	21D82133G30	36 ±10%; 75 v; N150
C25, 62	21D82428B56	0.0047 uf ±10%; 200 v
C26, 38, 41	21D82428B59	.01 uf +80-20%; 200 v
C27, 30, 32, 33	21D82133G35	56; NP0
C29	21C82450B13	1.5
C31	21D82450B08	1.2
C34, 35	21D82428B26	.02 uf +80-20%; 200 v
C36	21D82610C28	130; 200 v; N470
C37	21D82133G23	27 ±10%; NP0
C39	21D82133G72	6; N150
C40, 44	21D83003G01	1100; 100 v
C42	21D83003G03	150; 100 v
C43, 57, 63	21C82372C04	0.05 uf +80-20%; 25 v (C63 for NRE6051AB, NRE6052AB)
C45	21D82428B34	.0096 uf ±10%
C46, 47, 48, 49	21D82187B21	820 ±10%; 200 v
C50, 54, 55	21D83003G02	1500 ±2%; 100 v
C51	23D83590E01	c/o:
C51A		1250 uf +150-10%; 35 v
C51B		100 uf +150-10%; 35 v
C51C		100 uf +150-10%; 35 v
C51D		100 uf +150-10%; 35 v
C56	21D82428B36	.002 uf ±10%; 200 v
C58, 72, 73	8C83514E03	.047 uf ±10%; 50 v
C59, 66, 67	21C82372C01	0.1 uf +80-20%; 25 v (C66 for NRE6051AB, NRE6052AB)
C60	23D84669A19	100 uf +150-10%; 2 v
	or23D82601A25	100 uf +150-10%; 2 v
C64	21D82428B57	.0033 uf ±10%; 200 v (NRE6051AB, NRE6052AB)
C65	23D83214C20	10 uf ±20%; 20 v (NRE6051AB, NRE6052AB)
C69, 70, 71	21D82133G03	100; N750
C75	21D82877B06	30 ±10%; 75 v; N150
C76	21D82877B08	2.8 ±0.25 pf; 75 v; N150
C78	21D82877B21	5 ±10%; 75 v; N150
C79	21K847064	0.01 uf; 150 v
C80	23D83441B01	47 uf ±20%; 6 v
		SEMICONDUCTOR DEVICE, diode: (SEE NOTE I)
CR1, 3	48C82466H01	silicon
CR2	48D83461E02	silicon; zener type
CR5, 6	48C82139G01	germanium
CR7	48C83330G01	germanium
CR9	48C82363E03	silicon
CR11	48D82256C03	zener, 4.7 v
CR12	48C83329G02	silicon
		LAMP, incandescent,
DS1	65C83573E01	.065 amp, 12 v
		FUSE, cartridge 1-1/4 x 1/4"
F1	65K892098	3/10 amp, 125 v

REFERENCE SYMBOL	MOTOROLA PART NO	DESCRIPTION
		CONNECTOR, receptacle: (for reference only)
J1		
J3	9C83586E01	female; single cont; phono type
J4	28C83511G01	male; 4 cont.
J5	9C83479E01	female; 12 cont.
		JACK, telephone:
J2	9C83571E01	single circuit
		COIL, RF:
L2	24D83744G01	3-3/4 turns
L3	24D82723H11	choke; 0.20 uh
L4, 5, 6	24D83156G03	coded GRN; incl. 76B83607E01 COIL, tuning
L7	24D83744G02	4-1/4 turns
L8A	24D83744G04	2-1/2 turns
L8B	24D83744G06	1-1/4 turns
L11	24D83131B08	20 turns; coded RED-GRN, incl. 76K861425 CORE, tuning
L13	24D83744G07	3-1/4 turns
L14	24D82723H07	choke; 10 uh
L15	24D83131B12	37 turns; coded YEL-ORG, incl. 76B82451B09 CORE, tuning
L16	24B82036J01	3-1/4 turns
L18	24C83131B13	3-1/2 turns; coded YEL-WHT, incl. 76K861425 CORE, tuning
		LOUDSPEAKER, magnetic:
LS1	50D83566E01	3.2 ohm; 2-1/4 x 6-1/4"; oval
		TRANSISTOR: (SEE NOTE I)
Q1	48R869545	N-P-N; type M9545
Q2	48R869606	N-P-N; type M9606
Q3, 6	48R869482	N-P-N; type M9482
Q4, 7, 8, 9, 10, 11, 16, 17, 19	48R134665	N-P-N; type M54 (ORG), (Q17 for NRE6051AB, NRE6052AB)
Q5	48R869564	P-N-P; type M9564
Q12, 18	48R869514	P-N-P; type M9514 (Q18 for NRE6051AB, NRE6052AB)
Q13, 14	48R869595	P-N-P; type M9595
Q15	48R869484	P-N-P; type M9484
Q20	48R869483	N-P-N; type M9483
Q21	48R869570	N-P-N; type M9570
		RESISTOR, fixed: ±5%; 1/4 w
R1	6S185B59	22 ±10%; 1/8 w
R2	6S185B85	3.3K ±10%; 1/8 w
R3	6S185B83	2.2K ±10%; 1/8 w
R4	6S185B79	1K ±10%; 1/8 w
R5	6S185B90	8.2K ±10%; 1/8 w
R6	6S185B99	47K ±10%; 1/8 w
R7, 24, 26	6S10401A87	39K
R8, 12, 20, 22, 41	6S10401A79	18K (R41 for NRE6051AB, NRE6052AB)
R9, 45	6S10401A77	15K
R10	6S10401A67	5.6K
R11	6S10401A47	820
R13, 56	6S10401A57	2.2K
R14, 43, 44, 47	6S10401A83	27K
R15, 28, 40, 51	6S10401A73	10K (R40 for NRE6051AB, NRE6052AB)
R16	6S10401D08	270K
R17, 38, 46	6S10401A49	1K (R38 for NRE6051AB, NRE6052AB)
R18, 36, 57	6S10401A25	100
R19, 21, 23, 25, 27	6S10401B02	150K
R29	6S10401A53	1.5K
R30, 52	6S10401A41	470
R31	6S10401A27	120
R32, 54	6S10401A21	68
R33	6S10401A31	180
R35, 37	6S10401A65	4.7K
R39	18C83518E01	var; 5K ±20%; 125°C (NRE6051AB, NRE6052AB)
R42, 50	6S10401A81	22K
R48	18C83519E01	var; 25K; incl. a dpst switch (S1)
R49	6S10401A45	680
R50	6S10401D06	220K
R53	6S10401C01	10
R55	6S10401A35	270
R58	17C82350A07	1.5; 1 w
R60	6S10401A59	2.7K
R61	6S124B55	2.7
R63, 64	6S10401A85	33K

REFERENCE SYMBOL	MOTOROLA PART NO	DESCRIPTION
R65	6S185C05	120 ±10%; 1/8 w
R66	6S185B87	4.7K ±10%; 1/8 w
R67	6K128903	390 ±10%; 1/8 w
R68	6S185B75	470 ±10%; 1/8 w
R69	6S129806	33 ±10%
		SWITCH:
S1		p/o R48
		TRANSFORMER, RF:
T2	24D83156G04	coded YEL pri: 1 & 3; sec: 5, 4
T3	24D83517E03	pri: 4, 6; sec: 2, 3; tapped at 5
T4	24D83542E01	pri: 4, 3; sec: 1, 6
T8	24D83517E02	pri: F3, S3; tapped at T1, T2 & T3; sec: F2, S1, tapped at S2, F1
		TRANSFORMER, AF:
T5	25C83538E91	pri: 1, 2; res. 50 ohms max. sec: 3, 5; tapped at 4; total res 60 ohms max.
T6	25C83548E01	pri: 1, 3; tapped at 2; total res 4.38 ohms ±10% sec: 4, 5; res 0.26 ohms ±10%
		TRANSFORMER, power:
T7	25C83242E01	pri: 1, 2; res. 21 ohms ±10% sec: 3, 4; res. 0.87 ohms ±10%
		LAMPHOLDER:
XDS1	9B83567E02	midget type; spring loaded; screw base
		FUSEHOLDER:
XF1	9K865564	extractor post type
		RESONATOR, ceramic:
Y1	48D83192C11	452 kHz
Y2	48D83192C12	458 kHz
		CRYSTAL UNIT, quartz: (SEE NOTE II)
Y3	Type GN	15.890 MHz
Y4	Type YVSW-142	receiver IF
	NON-REFERENCED ITEMS	
	42A83941E01	CLAMP, cable
	26A82076C03	SHIELD, coil; 10 req'd.

NLN6585A Circuit Board EPD-17872-B

		SEMICONDUCTOR DEVICE, diode: (SEE NOTE I)
CR4	48C82466H01	silicon
CR7	48C82392B03	silicon
		FUSE, cartridge: 1-1/4" x 1/4"
F2	65S132937	slow-blow type; 1 a; 125 v
		RESISTOR, fixed:
R34	6S10401A39	390 ±5%; 1/4 w
	or6S129863	390 ±10%; 1/4 w

NKN6122A AC Power Cable Kit EPD-17873-A

P4		CONNECTOR, receptacle: p/o W1
P7		CONNECTOR, plug: p/o W1
W1	30D83562E02	CABLE ASSEMBLY, power: 2 cond; each cond. No. 18 ga. str. incl. two "molded-on" connectors (one female; ref. sym. P4, 4 cont., and one male, ref. sym. P7, 2 cont.); length overall 6 ft.

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION

PARTS LIST

NKN6123A DC Power Cable Kit EPD-17871-A

F3	65K804910	FUSE, cartridge: slow-blow type; 1 a; 125 v
P4		CONNECTOR, receptacle: p/o W2
W2	30D83562E01	CABLE ASSEMBLY, power: 2 cond; each cond. No. 18 ga. str. incl. two "molded-on" conn. (one female, ref. sym. P4, 4 cont. and one male, 2 cont) length overall 6 ft.

NHN6178A Housing & Panel Kit
NHN6162A Housing & Panel Kit EPD-24496-O

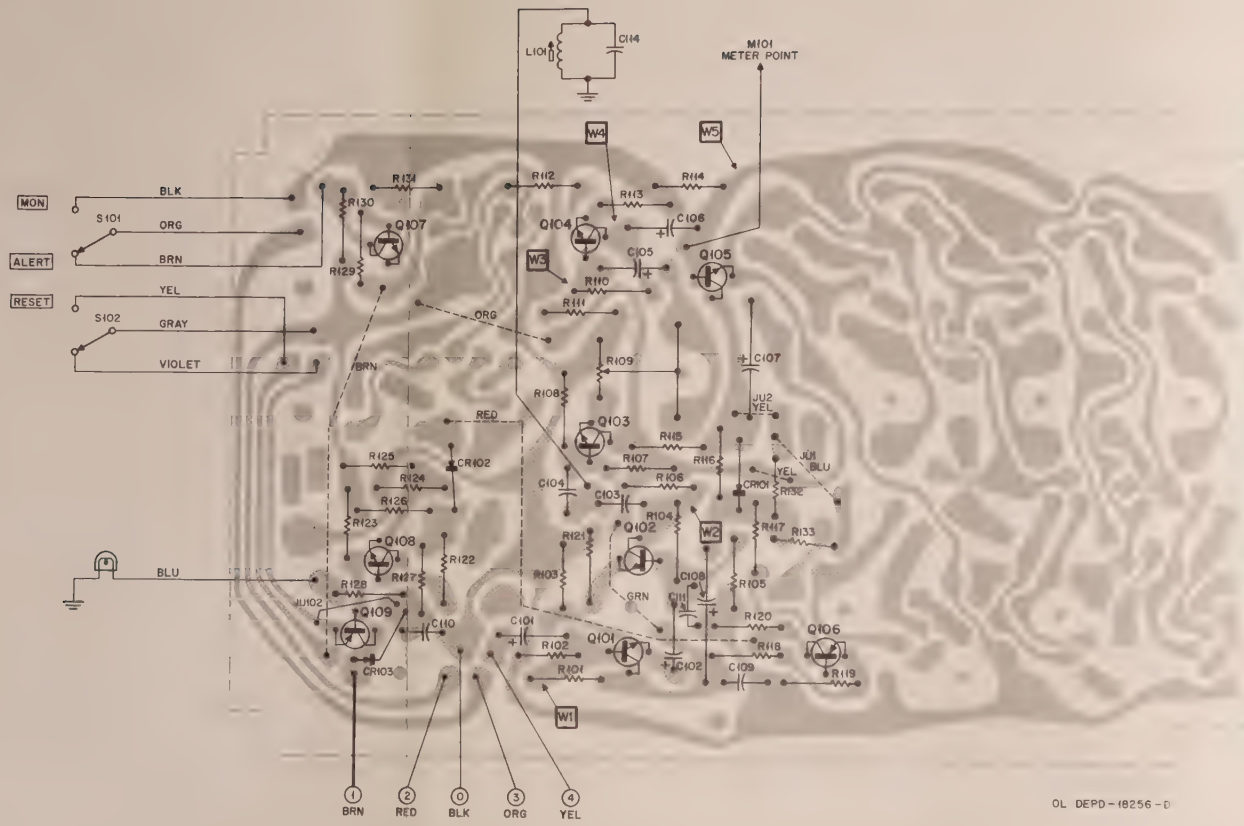
	15D83578E01	HOUSING
	3A83485E03	SCREW, captive
	7B83827E01	BRACKET, antenna conn.
	1V80770A80	HANDLE, assem.
	36C82628H09	KNOB, volume
	36C82628H08	KNOB, squelch (NHN6162A)
	64D83386E01	PANEL, front
	32B83563E01	GASKET, speaker
	13B83560E01	ESCUTCHEON, bottom (NHN6162A)
	13B83560E02	ESCUTCHEON, bottom (NHN6178A)

NLN6647A Tamper-Proof "Private-Line" Escutcheon Kit
NLN6646A "Private-Line" Escutcheon Kit
NLN6580A Escutcheon Kit
NLN6579A Escutcheon Kit EPD-24501-O

	13B83561E03	ESCUTCHEON (NLN6575A)
	13B83561E02	ESCUTCHEON (NLN6580A)
	13B83561E04	ESCUTCHEON (NLN6646A)
	13B83561E05	ESCUTCHEON (NLN6647A)
	61A83603E01	LENS, BLU
	61A83604E01	LENS, RED (NLN6580A, NLN6647A)

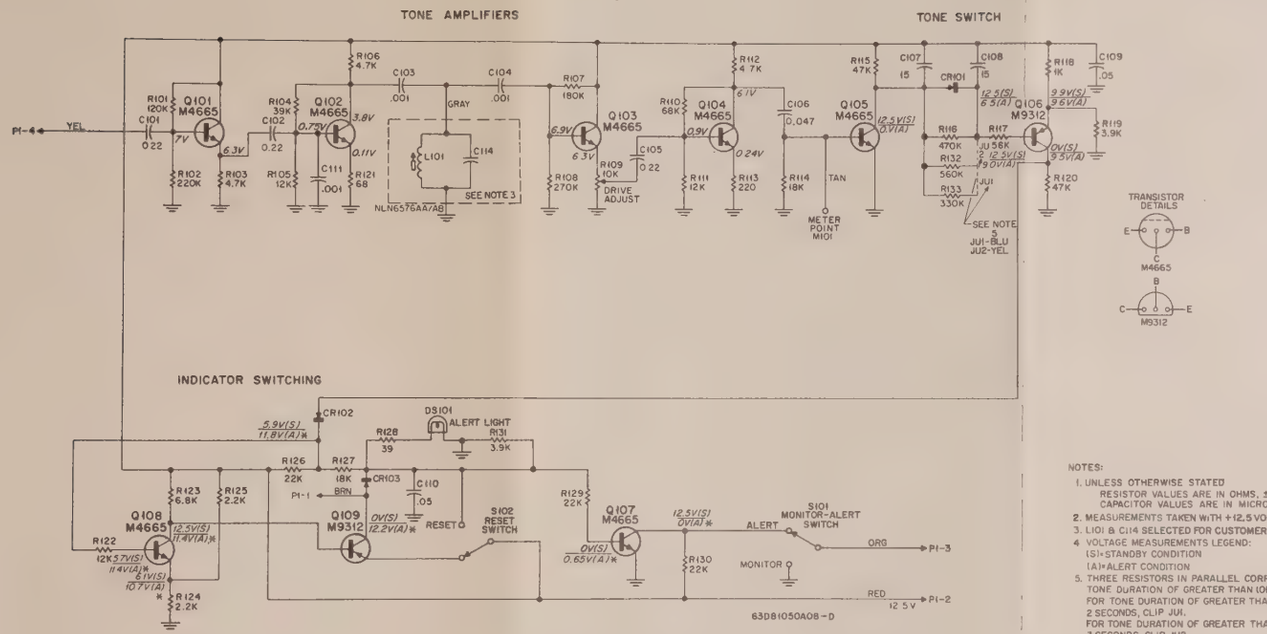
REVISIONS

DIAG ISSUE	CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
A	NLN6568A-1	R116	WAS 39K	RIGHT OF Q103
	NLN6568A-2	XDS101	WAS 9B83567E01	PARTS LIST
B	NLN6568A-2	C111	ADDED	Q102 BASE
C	NLN6568A-3	R116	WAS 6S128903, 39K	Q105 COLLECTOR
		R132	ADDED, 560K	CENTER OF CKT. BD.
		R133	ADDED, 330K	
D	NLN6568A-4		PLATING REVISED	RIGHT SIDE OF CKT. BD.
		C107, 108	WAS 23K865136	PARTS LIST
		CR101, 102	WAS 48C82392B02	Q105 COLLECTOR
		CR103	ADDED	P1-1
E	NLN6568A-4	C10..,105	WAS 23K865136	PARTS LIST
		CR101 102	WAS 48C82392B02	Q105 COLLECTOR
		CR103	ADDED	P1-1



Model NLN6568A
Single-Tone Decoder Unit
Printed Circuit Board Detail
Motorola No. PEPD-18257-E

BEPD-20880-O



63D81050A08-D

* ALERT VOLTAGE READINGS ARE MAINTAINED UNTIL INDICATOR SWITCHING CIRCUIT IS MANUALLY RESET BY S102.

NOTES:
1. UNLESS OTHERWISE STATED
   RESISTOR VALUES ARE IN OHMS, ±10%, 1/4 WATT.
   CAPACITOR VALUES ARE IN MICROFARADS.
2. MEASUREMENTS TAKEN WITH +12.5 VOLTS DC
3. L101 & C114 SELECTED FOR CUSTOMER TONE FREQUENCY
4. VOLTAGE MEASUREMENTS LEGEND:
   (S)=STANDBY CONDITION
   (A)=ALERT CONDITION
5. THREE RESISTORS IN PARALLEL CORRESPOND TO ENCODER TONE DURATION OF GREATER THAN (OR EQUAL TO) 1.0 SECOND.
   FOR TONE DURATION OF GREATER THAN (OR EQUAL TO) 2 SECONDS, CLIP JU1.
   FOR TONE DURATION OF GREATER THAN (OR EQUAL TO) 3 SECONDS, CLIP JU2.

REVISIONS

DIAG ISSUE	CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION	REFER TO CIRCUIT BOARD
A	NLN6568A-1	R116	WAS 6S128903, 39K	Q105 COLLECTOR	DECODER BD. PEPD-18257-Q
B	NLN6568A-2	XDS101	WAS 9B83567E01	PARTS LIST	DECODER BD. PEPD-18257-A
B1			VOLTAGE READINGS & WAVEFORMS ADDED	SCHEMATIC DIAGRAM	
L2	NLN6568A-Z	C111	ADDED WAS CONNECTED TO PLATING SIDE OF BD.	Q102 BASE	DECODER BD. PEPD-18257-B
C	NLN6568A-3	R116	WAS 6S128683, 150K	Q106 BASE	PEPD-18257-C
		R132	ADDED 560K		
		R133	ADDED 330K		
D	NLN6568A-4	CR101, 102	WAS 48C82192B02	Q105 COLLECTOR	PEPD-18257-E
		CR103	ADDED	PI-1	
		C107, 108	WAS 23K865136	PARTS LIST	

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
NLN6576AA Tone Kit NLN6576AB Tone Kit		EPD-17815-A
C114	8D83445B58 or8D83445B59 or8D83445B60 or8D83445B61 or8D83445B62 or8D83445B63 or8D83445B64	CAPACITOR, fixed: uf ±1%; 50 v 0.079 0.067 0.064 0.058 0.053 0.050 0.044 Factory Selected
L101	24V80905A99 or24V80906A01	COIL ASSEMBLY: incl: 24C83194A03 COIL WINDING; coded GRN; 76B83066A04 CORE, tuning; 7A83064A01 BRACKET, coil retaining; 4A83065A01 WASHER; 64A83063A01 PLATE, coil mtg. 3S1990 MACHINE SCREW; 29S5369 LUG, solder; Model NLN6576AA only incl: 24C83194A02 COIL WINDING; coded RED; 76B83066A04 CORE, tuning; 7A83064A01 BRACKET, coil retaining; 4A83065A01 WASHER; 64A83063A01 PLATE, coil mtg. 3S1990 MACHINE SCREW; 29S5369 LUG, solder; Model NLN6576AB only

NOTE:

Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION

PARTS LIST

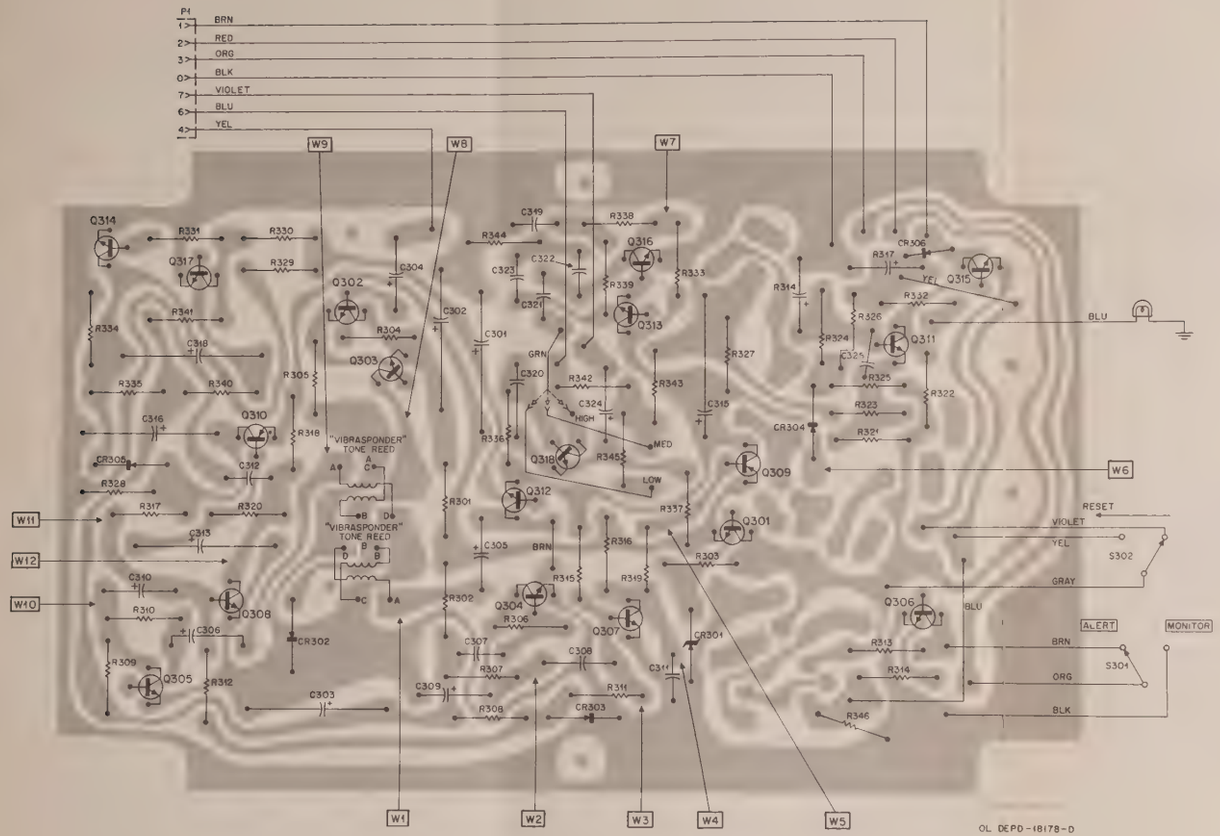
NLN6568A Single-Tone Decoder EPD-17816-D

		CAPACITOR, fixed: uf; ±10%; unl stated
C101, 102, 105	8D82905G11	0.22; 50 v
C103, 104, 111	21D83596E01	.001; 500 v
C106	8D82905G03	.047; 100 v
C107, 108	23D83214C02	15; 25 v
C109, 110	21C82372C04	.05 +80-20%; 25 v
		SEMICONDUCTOR DEVICE, diode: (SEE NOTE)
CR101, 102, 103	48C83654H01	silicon
		LAMP, incandescent:
DS101	65C83573E01	.065 amp; 12 v
		TRANSISTOR: (SEE NOTE)
Q101 thru 105, 107, 108	48R134665	N-P-N; type M4665
Q106, 109	48R869312	P-N-P; type M9312
		RESISTOR, fixed ±10%; 1/4 w unl stated
R101	6S128987	120K
R102	6S129147	220K
R103, 106, 112	6S127804	4.7K
R104	6S128903	39K
R105, 111, 122	6S129230	12K
R107	6S129229	180K
R108	6S129227	270K
R109	18C82193H05	var: 10K
R110	6S129144	68K
R113	6S127800	220
R114, 127	6S128904	18K
R115, 120	6S128902	47K
R116	6S129148	470K
R117	6S129242	56K
R118	6S127802	1K
R119, 131	6S129232	3.9K
R121	6S129861	[illegible]
R123	6S128687	[illegible]
R124, 125	6S12[illegible]	[illegible]
R126, 129, 130	6S12[illegible]	[illegible]
R128	6S131452	39
R132	6S129247	560K
R133	6S129228	330K
		SWITCH, [illegible]
S101	40B83890A02	dpdt
S102	40B83547E01	spst
		LAMPHOLDER
XDS101	9B83567E02	midget type; spring loaded; screw base
NON-REFERENCED ITEM		
	9A83445D01	CONNECTOR, receptacle: male single cont.

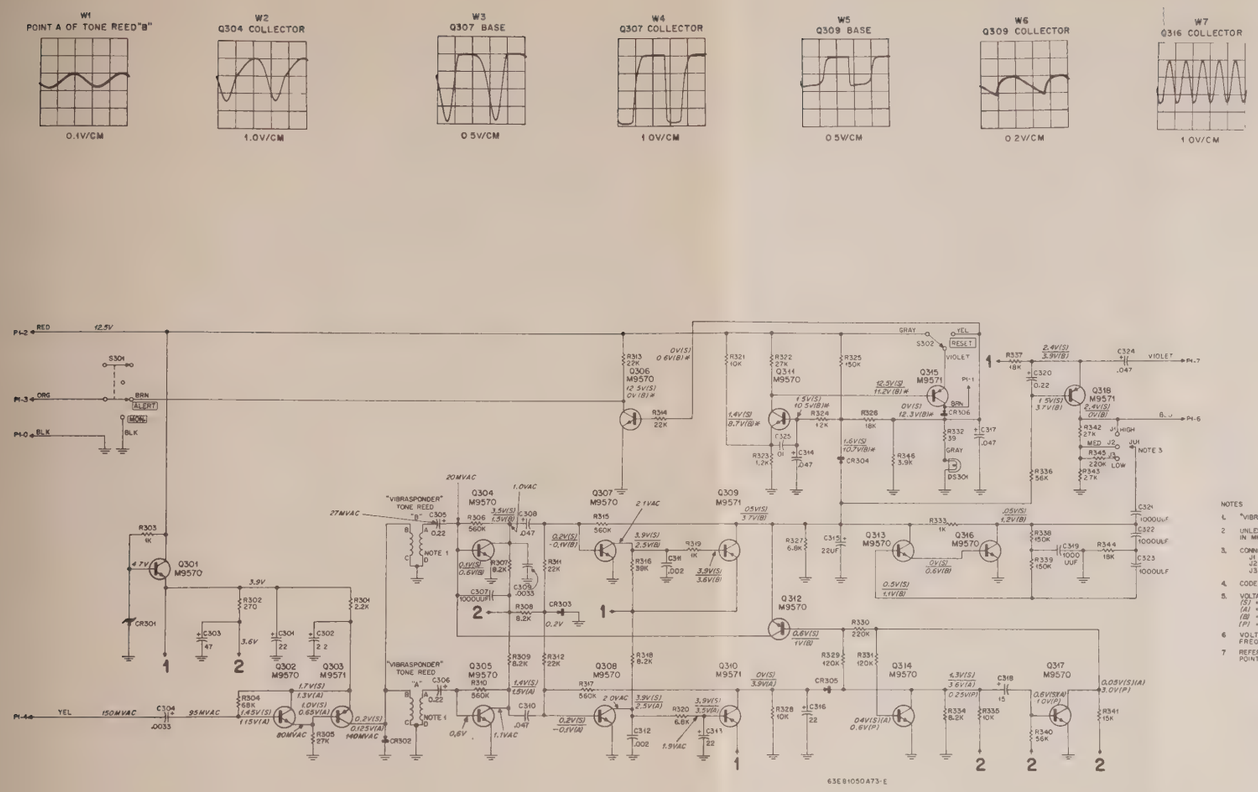
Model NLN1046A
Single-Tone Decoder Unit
Schematic Diagram
Motorola No. 63D81050A08-D

REVISIONS

DIAG. ISSUE	BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
A	NLN6578A-1	C325	ADDED	Q311 EMITTER
		C321	WAS 220 Ωuf	Q316 COL-LECTOR
		R342	WAS 18K	Q318 COL-LECTOR
		R345	WAS 560K	RIGHT OF Q_{318}
		R343	WAS 15K	
		R344	WAS 6.8K	LEFT OF Q_{316}
		C303	WAS 22 uf	RIGHT OF Q_{305}
B	NLN6578A-2	XDS301	WAS 9B81567E01	PARTS LIST
C	NLN6578A-3	C325	WAS 21K8473b4, 150 V	PARTS LIST
D	NLN6578A-4	C302	WAS 23D82314C07 22 uf	Q302 COLLECTOR
		R304	WAS 6K129226 100K	Q302 BASE
E	NLN6578A-5	CR304	WAS 48R82392B04	RIGHT OF Q309
		CR306	ADDED	Q315 COL-LECTOR
		C302	WAS 23D83397D07	PARTS LIST
		C301, 313, 315, 316	WERE 23D83214C07	



Model NLN6578A
Two-Tone Sequential Decoder Unit
Printed Circuit Board Detail
Motorola No. PEPD-18179-E



* ONCE ALERTED THIS VOLTAGE REMAINS IN THE ALERT CONDITION UNTIL RESET SWITCH S302 IS ACTIVATED

NOTES

1. "VIBRASPONDER" RESONANT REEDS SUPPLIED SEPARATELY.
2. UNLESS OTHERWISE STATED, CAPACITOR VALUES ARE IN MICROFARADS.
3. CONNECT JUM TO:
   J1 FOR HIGH LEVEL ALERT TONE, (2W)
   J2 FOR MEDIUM LEVEL ALERT TONE, (500MW)
   J3 FOR LOW LEVEL ALERT TONE, (50MW)
4. CODE SEQUENCE A-B
5. VOLTAGE READINGS LEGEND:
   /S/ = STANDBY CONDITION
   /A/ = TONE "A" APPLIED TO REED DRIVER
   /B/ = TONE "B" APPLIED TO REED DRIVER
   /P/ = PULSE AT END OF TONE "A"
6. VOLTAGE READINGS WILL VARY DEPENDING ON FREQUENCY OF TONES USED
7. REFER TO CIRCUIT BOARD DETAIL FOR MEASUREMENT POINTS

DEPD-20881-A

REVISIONS

DIAG ISSUE	CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION	REFER TO CIRCUIT BOARD
[illegible]	NLN6578A	[illegible]	[illegible]	Q318 COLLECTOR	DECODER BD. PEPD-18179-A
		R145	WAS 6S129247, 560K		
		R343	WAS 6S127805, 15K		
		R144	WAS 6S128687, 6.8K	Q316 COLLECTOR	
		[illegible]	[illegible]	[illegible]	
A	NLN6578A-1	[illegible]	WAS 21D83214C07, 22 uf	Q101 EMITTER	DECODER BD. PEPD-18179-A
B	NLN6578A-2	XDS301	WAS 9B83567E01	PARTS LIST	PEPD-18179-B
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C	NLN6578A-3	[illegible]	WAS 21K847064, 150 V	PARTS LIST	PEPD-18179-C
	NLN6578A-3	[illegible]	[illegible]	PARTS LIST	NONE
D	NLN6578A-4	C302	WAS 23D83214C07, 22 uf ±20%, 15 V	Q101 EMITTER	PEPD-18179-C
		[illegible]	WAS 6K129226, 100K	Q102 BASE	
D1	NLN6578A-4	[illegible]	ADDED, 6S128594, 1.2K	SCHEMATIC DIAGRAM	NONE
		[illegible]	ADDED, 6S128594, 1.2K		
		Q3[illegible]	ADDED, 6S128594, 1.2K		
		[illegible]	[illegible]		
E	NLN6578A-5	R[illegible]	WAS [illegible]	Q101 BASE	PEPD-18179-E
		[illegible]	ADDED	Q318 COLLECTOR	
		[illegible]	[illegible]	[illegible]	
		[illegible]	ADDED, 6S128594, 1.2K	PARTS LIST	
		[illegible]	[illegible]	[illegible]	

PARTS LIST

NLN6578A Two-Tone Sequential Decoder Kit EPPD-18216-F

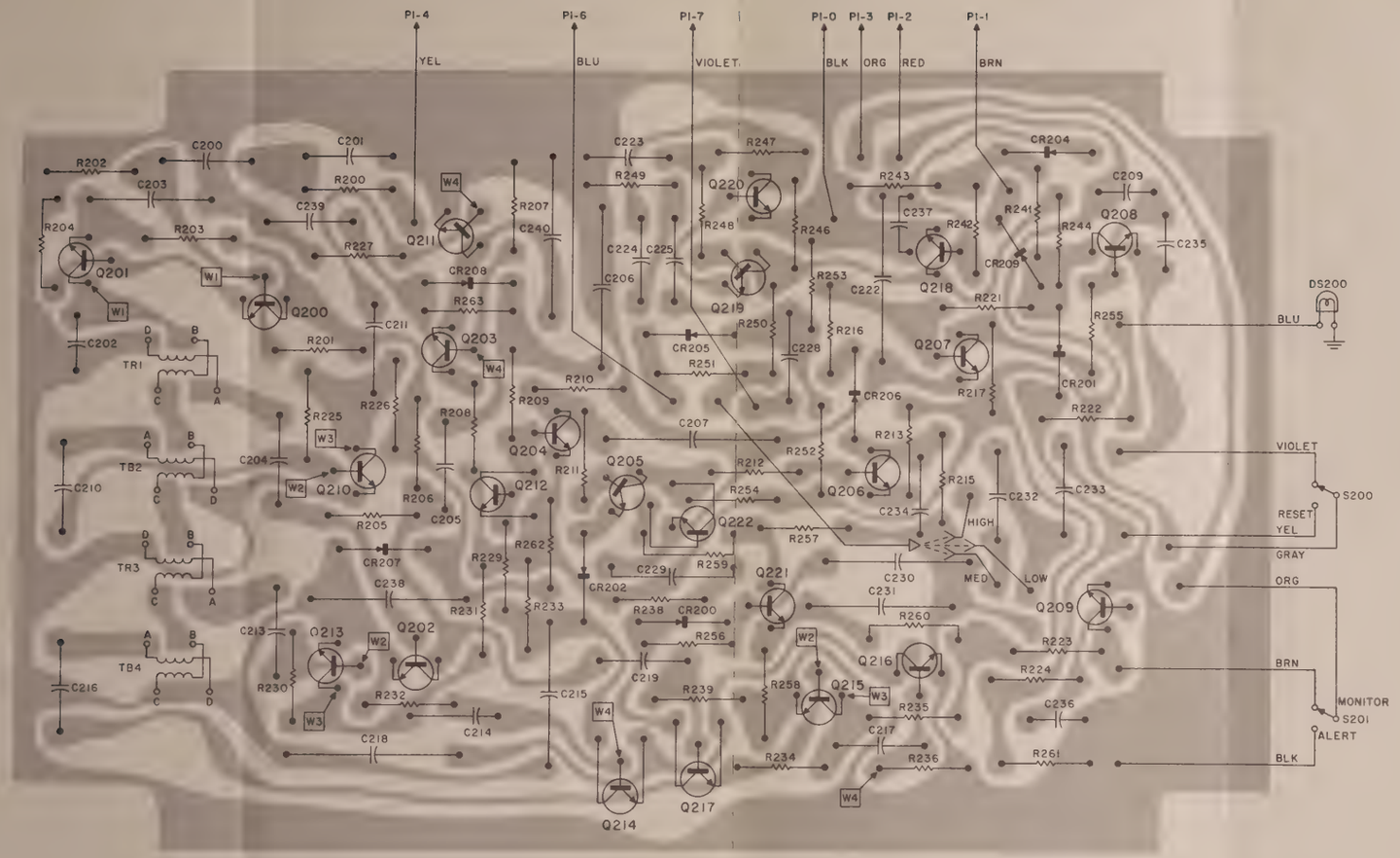
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uf ±10%; 50 v; unl stated
C301, 313, 315, 316	23D83397D16	22 ±20%; 10 v
C302	23D83397D07	2.2 UF; 15 v
C303	23K868445	47 ±20%; 6 v
C304, 309	8D82905G25	.0033, 100 v
C305, 306, 320	8D82905G11	0.22
C307, 319, 321, 322, 323	21D83596E01	.001; 500 v
C308, 310, 314, 317, 324	8D82905G03	.047
C311, 312	21D82428B25	.002 ±20%; 500 v
C318	23D83214C02	15 ±20%; 25 v
C325	21D82428B12	.01 +70-30%, 100 v
		SEMICONDUCTOR DEVICE, diode: (SEE NOTE I)
CR301	48D83461E10	zener
CR302, 303	48C82178A06	germanium
CR304, 306	48C83654H01	silicon
CR305	48K855216	germanium
		LAMP, incandescent:
[illegible]	65C83573E02	.065 amp; 14 v
		TRANSISTOR (SEE NOTE I) N-P-N; type M9570
Q301, 302, 304 thru 308, 311 thru 314, 316, 317	48R869570	
Q303, 309, 310, 315, 318	48R869571	P-N-P; type M9571
		RESISTOR, fixed ±10%, 1/4 w unl stated
R301	6S128689	2.2K
R302	6S129752	270
R303, 319, 333	6K127802	1K
R304	6S129144	68K
R305, 322, 342	6S127806	27K
R306, 310, 315, 317	6S129247	560K
R307, 308, 309, 318, 334	6S128686	8.2K
R311, 312, 313, 314	6S128685	6.8K
R316	6K128903	39K
R320, 327	6S128687	6.8K
R321, 328, 335	6S129225	10K
R323	6K129235	1.2K
R324	6S129230	12K
R325, 338, 339	6S128683	150K ±5%
R326, 337, 344	6S128904	18K
R329, 331	6S128987	120K
R330, 345	6S129147	220K
R332	6S131652	39
R336, 340	6S129242	56K
R341	6S127805	15K
R343	6S128688	2.7K
R346	6S129232	3.9K
		SWITCH, slide
S301	40B83890A02	dpdt
S302	40B83547E01	spdt
		LAMPHOLDER
XDS301	9B83567E02	miniature; screw base
	NON-REFERENCED ITEMS	
	9C83035A01	SOCKET, reed: min; 4 cont.
	9C83035A03	SOCKET, reed: min; 4 cont.
"Vibrasponder" Reed		
	TLN6709BG	625-1350 cps (SEE NOTE II)

NOTES:

I. Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.

II. When ordering replacement "Vibrasponder" Resonant Reeds, specify exact reed frequency required.

Model NLN6578A
Two-Tone Sequential Decoder
Schematic Diagram
Motorola No. 63E81050A73-E



80-DEPD-21986-C
OL-DEPD-21987-B

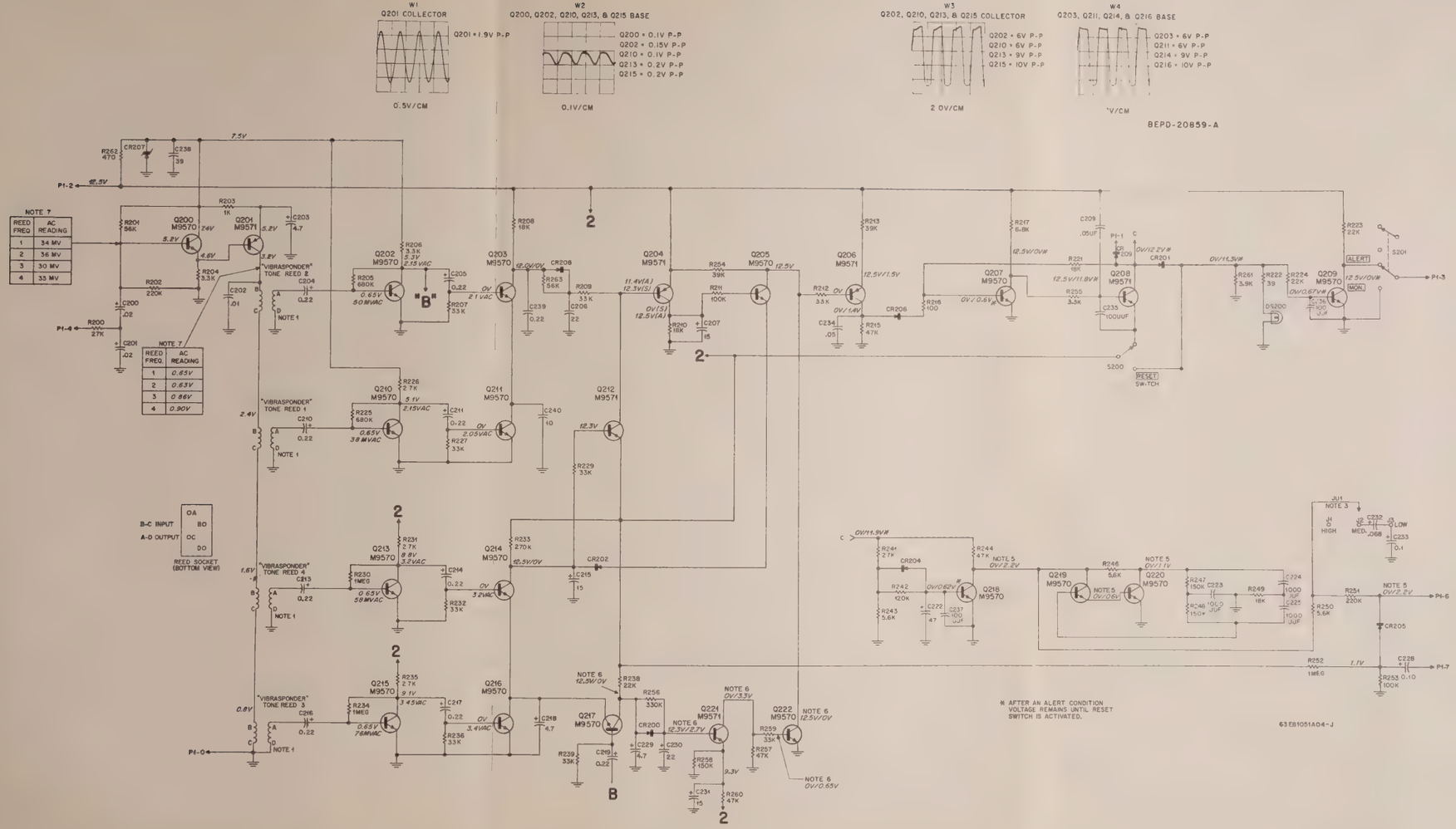
REVISIONS

DIAG ISSUE	BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
O	NLN6577A-6	C238	WAS 23D82397D18	[illegible]
		C239	WAS 23D82397D06	Q221 COLLECTOR
			PLATING CHANGED	
A	NLN6577A-7	C230	WAS 23K865136 15 UF	Q221 BASE
		[illegible]	WAS 48C82392B03	
		[illegible]	WAS 48C82921G04	Q208 COLLECTOR
B	NLN6577A-8	C207, 215, 231	WERE 23K865136	PARTS LIST
		CR200, 202, 205	WERE 48C836541H01	
		CR207	ADDED	
		[illegible]	ADDED [illegible]	
		[illegible]	WAS [illegible]	
		R262	ADDED, 470	
C	NLN6577A-9	CR209	ADDED DIODE	Q208 COLLECTOR CKT.

MODEL	SUFFIX
NLN6577A	-6

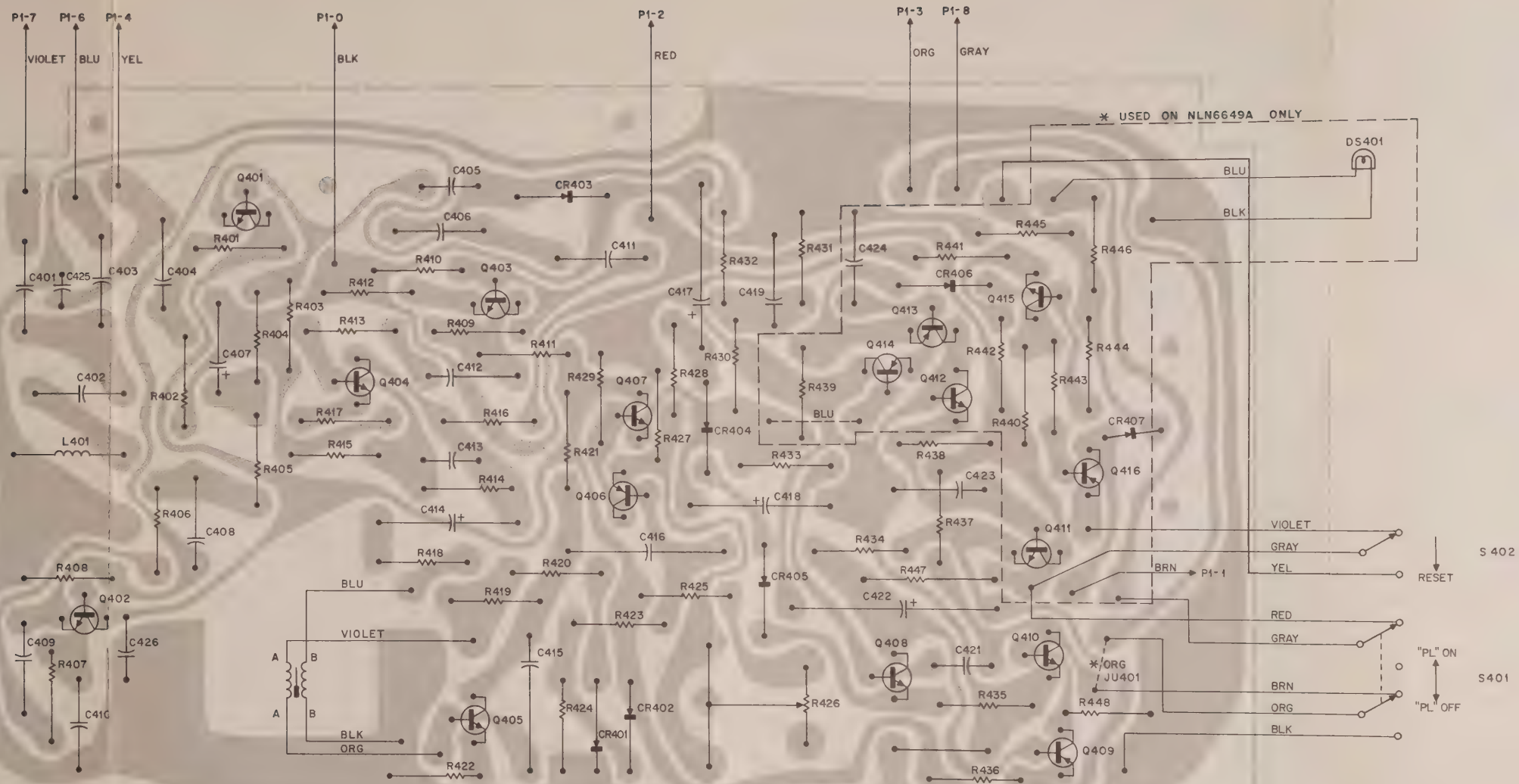
FOR MODEL SUFFIX EARLIER THAN INDICATED IN THIS CHART, REFER TO CIRCUIT BD. PEPD-18260.

EPD-22127-B

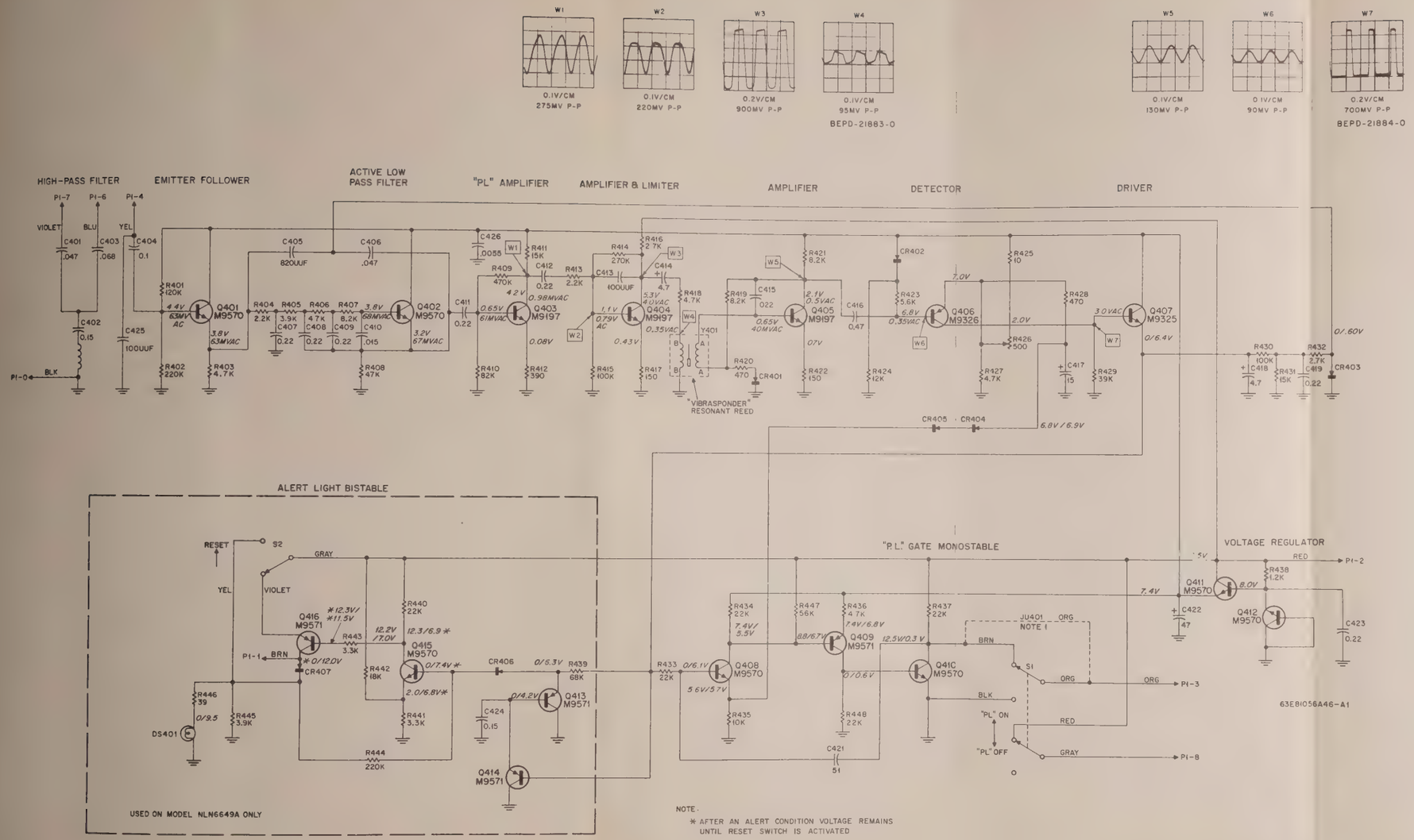


REVISIONS

DIAG ISSUE	CHASSIS AND SUFFIX NO	REF SYMBOL	CHANGE	LOCATION	REFER TO CIRCUIT BOARD
				Q214 BASE	ORDER BD
			ADDED .05 uF	Q206 COLLECTOR	PEPD-18265-B
	NLN6577A		RELOCATED WAS	Q206 COLLECTOR & Q207 LIT	
	NLN6577A-1	C218	WAS 29K865330, .15 uF	ORDER BD TOP	
		CR206, R210	WAS 48C821903 & 19A705437 T-1/2	PARTS LIST & Q206 COLLECTOR TOP	
			ADDED	Q206 COLLECTOR	
			ADDED		
			DELETED 29K865330		
	NLN6577A-3				
	NLN6				
			ADDED		
			ADDED		
			ADDED		



OL DEPD-20921-C



NOTES

1. IN TAMPER-PROOF MODEL, S1 IS REPLACED BY JU401.
2. ALL CAPACITANCES ARE IN MICROFARADS EXCEPT WHERE OTHERWISE NOTED.
3. "VIBRASPONDER" RESONANT REED SUPPLIED SEPARATELY.
4. DC VOLTAGE READINGS TAKEN WITH 13.8 VOLTS DC INPUT, AND ARE REFERRED TO CHASSIS GROUND. S = STANDBY CONDITION, O = VOLTAGE DURING "PRIVATE-LINE" OPERATION.

EPD-21376-O

PREVIOUS REVISIONS AND PARTS LIST SHOWN ON BACK OF THIS DIAGRAM

Models NLN6648A, NLN6649A
"Private-Line" Decoder Units
Schematic Diagram
Motorola No. 63E81056A46-A1

REVISIONS

DIAG. ISSUE	CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION	REFER TO CIRCUIT BOARD
01	NLN6648A NLN6649A	R404	WAS 6S129232, 3.9K	Q401 EMITTER	PEPD-20922-A
		R405	WAS 6S129225, 10K		
		R406			
		R408	WAS 6S127805, 15K	Q402 EMITTER	
		R444	WAS 6S129242, 56K	Q415 BASE	
		C407, 408,409	WERE 8D82905G07	Q402 BASE	
		C410	WAS8D82905G23,.02 uf		
02	NLN6648A NLN6649A	R420	WAS 6S129753, 100	Y401-A	PEPD-20922-B
		R434	WAS 6S128902, 47K	Q408 COLLECTOR	
		R436	WAS 6S128686, 8.2K	Q409 EMITTER	
		R447	ADDED 56K	Q409 BASE	
		R448	ADDED 22K		
A	NLN6648A-1 NLN6649A-1	C414, 418	WERE 23K865137, 4.7 uf	PARTS LIST	PEPD-20922-D
		C417	WAS 23K865136, 15 uf		
		CR402, 404, 405, 406	WERE 48C82392B03		
		CR407	ADDED 48C83654H01	Q416 COLLECTOR	
A1	NLN6648A-1 NLN6649A-1		WAVEFORMS ADDED		

PARTS LIST

NLN6648A "Private-Line" Decoder and Filter Kit
NLN6649A "Private-Line" Decoder and Filter Kit EPD-21299-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uf ±10%; 50 v, unl. stated
C401, 406	8D82905G03	.047
C402	8D82905G05	0.15
C403	8D82905G04	.068
C404	8D82905G07	.10
C405	21D82187B21	820; uuf; 200 v
C407, 408, 409, 411, 412, 419, 423	8D82905G11	0.22
C410	8D82905G10	.015
C413, 425	21D82133G03	100 uuf ±5%
C414, 418	23D83397D15	4.7 ±20%; 20 v
C415	8D82905G43	.022; 200 v
C416	8D82905G49	0.47
C417	23D83214C02	15 ±20%; 25 v
C421	21D82428B12	.01; 100 v
C422	23D82783B31	47 ±20%; 20 v
C424	8D82905G05	0.15 (NLN6649A only)
		SEMICONDUCTOR DEVICE: diode; (SEE NOTE)
CR401, 403	48C82392B03	silicon; SG3182
CR402, 404, 405, 406, 407	48C83654H01	silicon
		LAMP, incandescent:
DS401	65C83573E01	min. screw base; .065 amps. 12 v (NLN6649A only)
		COIL, AF
L401	25C82024D02	choke; 6.6 h
		TRANSISTOR: (SEE NOTE)
Q401, 402, 408, 410, 411, 412	48R869570	N-P-N; type M9570
Q403, 404, 405	48R869197	N-P-N; type M9197
Q406	48R869326	P-N-P; type M9326
Q407	48R869325	N-P-N; type M9325
Q409	48R869571	N-P-N; type M9571
Q413, 414, 416	48R869571	N-P-N; type M9571 (NLN6649A only)
Q415	48R869570	N-P-N; type M9570 (NLN6649A only)
		RESISTOR, fixed ±10%; 1/4 w; unl. stated
R401	6S128987	120K
R402, 444	6S129147	220K
R403, 418, 427, 436	6S127804	4.7K
R404, 413	6S128689	2.2K
R405	6S129232	3.9K
R406, 435	6S129225	10K
R407, 419, 421	6S128686	8.2K
R408	6S128902	47K
R409	6S129148	470K
R410	6S129145	82K
R411, 431	6S127805	15K
R412	6S129863	390
R414	6S129227	270K
R415, 430	6S129226	100K
R416, 432	6S128688	2.7K
R417, 422	6S129862	150
R420, 428	6S127801	470
R423	6S129433	5.6K
R424	6S129230	12K
R425	6S129755	10
R426	18C82193H08	var, 500 ohms; ±10%; 1/4 w
R429	6S128903	39K
R433, 434, 437, 448	6S128685	22K
R438	6S129235	1.2K
R439	6S129144	68K (NLN6649A only)
R440	6S128685	22K (NLN6649A only)
R441, 443	6S129231	3.3K (NLN6649A only)
R442	6S128904	18K (NLN6649A only)
R445	6S129232	3.9K (NLN6649A only)
R446	6S131652	39 (NLN6649A only)
R447	6S129242	56K

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		SWITCH, slide:
S401	40B83890A02	dpdt
S402	40B83547E01	spdt (NLN6649A only)
		LAMPHOLDER,
XDS401	9B83567E02	min. screw base (NLN6649A only)

NOTE:

Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.

3100A